Journal of PSYCHOSOMATIC RESEARCH

VOL.
1
1956

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VOLUME 1 1956

Pergamon Press *London & New York*

JOURNAL OF PSYCHOSOMATIC RESEARCH

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Publishing Offices: 4 & 5 *Fitzroy Square, London W.*1 (*EUS.* 4455)
Issued in parts. Subscription per volume (*A*) £6 (*U.S.A.* $17.00) *including postage;* (*B*) *for individual subscribers certifying that the journal is for their private use,* £3 10*s.* (*U.S.A.* $9.80) *including postage.*
Distributed by I. R. Maxwell & Co. Ltd., 4 & 5 *Fitzroy Square, London W.*1
and Pergamon Press, Inc., 122 *East* 55*th Street, New York* 22, *N.Y.*

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EDITORIAL

PSYCHOSOMATIC RESEARCH

PSYCHOSOMATIC medicine is not, in its essential features, a new science. Historically, the psychosomatic approach to clinical problems can be traced to ancient times, and indeed formed a prominent part of Hippocratic medicine. As a field of research, however, psychosomatic medicine has mainly developed during the past two or three decades.

Psychosomatic medicine has as its objective the understanding of man, neither as an exclusively physical nor as an exclusively psychic being, but as an integrated totality. The term psychosomatic medicine is not altogether satisfactory, as it connotes a duality of body and mind rather than a body-mind unity. As yet, no satisfactory alternative term has been generally accepted to denote the modern conception of the field of psychosomatic medicine as comprising both body-mind unity and the organism-environment continuum.

It may therefore be preferable to speak of a psychosomatic attitude, approach, or tendency with regard to medicine, rather than psychosomatic medicine as a special subject. It is not, and never has been, a speciality, but is a method of approach applicable to the whole field of medicine. It is indeed to be hoped that any semblance it has to being a separate discipline will disappear when its facts and principles are fully assimilated into the practice and teaching of general medicine.

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While considerable advances have already been achieved by the application of modern methods and techniques to the study of many aspects of psychophysical relations, the amount of exact knowledge of psychosomatic and somato-psychic interactions is still very meagre.

Nowhere in medicine is there such a contrast between the wide span of theories and their narrow factual basis.

Psychosomatic medicine at present suffers from a surfeit of unverified or inadequately validated hypotheses and a paucity of established facts. The paucity of factual knowledge concerning the interaction between *psyche* and *soma* in health and disease is the more conspicuous now because, as a result of the intensive work of the past half-century, our knowledge in both the psychic and somatic field has grown and deepened so considerably.

Failure to apply appropriate scientific methods has been largely responsible for impeding progress in the study and understanding of psychosomatic interactions.

The conviction that a suitable methodology is the first prerequisite for further advances in psychosomatic medicine in its present stage of development, forms one of the main reasons why the editors have started this new journal and named it a journal of research.

For the future advancement of our knowledge of psychosomatic relationships, it will be necessary for workers in the field to keep as conscious objectives the need for the careful framing of hypotheses and their testing by well-planned experiments, utilizing all necessary controlled procedures and statistical methods. It is the constant endeavour to prove or disprove which has brought science to its present triumphal

1

development, and which we hope will also ultimately bring more light into the darkness which still envelops many of the problems to which this journal will be devoted.

It is not intended to apply strict limits to the scope of matter published in the journal. The scope is intended to include, for example, controlled clinical investigations, animal or human experimental work, and relevant studies from related fields such as psychology, sociology, and anthropology.

The editors will aim at being eclectic and will welcome, from any field of investigation, contributions which either serve to advance our knowledge of psychosomatic relationships or help in the development of improved methods and techniques in psychosomatic research.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 3 to 20. Pergamon Press Ltd., London

EMOTIONS AND THE PERIPHERAL VASOMOTOR SYSTEM

A REVIEW OF PREVIOUS WORK

BRIAN ACKNER, M.D.*

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THE MEASUREMENT OF HUMAN PERIPHERAL VASOMOTOR ACTIVITY

THE assessment of human peripheral vasomotor activity is derived from the recording of various peripheral circulatory changes and is necessarily indirect. The various methods available involve the measurement of different tissue quantities or qualities whose variations are related to a greater or less extent to changes in the peripheral circulation. BURTON (1954) has coined the phrase "The reactive error in physiology" to describe the reaction of the organism to the stimulus of the application of the method of measurement. The avoidance of this error is, of course, essential in any investigation involving emotional factors, and necessitates the use of apparatus which is simple and easy to apply together with methods of recording which are as unobtrusive as possible. These requirements exclude many techniques which are otherwise satisfactory, and, in practice, the majority of previous work on emotional factors in relation to the peripheral circulation has been carried out utilizing either a thermal or a plethysmographic method. Various practical considerations associated with these techniques will now be considered in more detail.

Thermal Methods

The measurement of variations in the skin temperature as an index to the peripheral blood-flow has been widely practised and is certainly one of the easiest methods to apply. There are, however, various errors inherent in this method, unless many factors are taken into account. A basic assumption is that there is a constant temperature gradient from the core of the area under measurement to the point of recording on the skin. For various reasons this can not always be a valid assumption. Local factors, such as the blood-flow down the length of the arm, the volume of blood, and the state of hydration of the tissues must all affect the skin temperature. The temperature-regulating function of the skin is obviously capable of causing major alterations in the skin temperature, which will thus no longer directly reflect the blood-flow of the whole part. As has been shown by ROTH and SHEARD (1950), factors influencing basal heat production must be considered when measuring skin temperature, for, when the metabolic rate is changed even by the ingestion of food, the skin temperature will increase proportionally. External factors leading to cooling or heating of the body must also be strictly controlled. The temperature of the examining room must be constant and draught-free, the subject must not be inadequately or excessively covered, and the part under examination must be free

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from moisture which would lead to cooling by evaporation. The limb position during recording is another factor of major importance. UPRUS, GAYLOR, and CARMICHAEL (1936) and ROTH, WILLIAMS, and SHEARD (1938) observed changes in skin temperature of the extremities produced by changes in posture. GOETZ (1950) studied the finger plethysmographic and skin-temperature response to induced changes in vasomotor tone, as produced by body heating, in limbs tested in different postures. He found that elevating the limb caused a marked drop in skin temperature and a reduction in finger volume, but an increase in the amplitude of the pulse volume. As the pulse volume was well above the normal minimal vasodilatation level, the arterial circulation could be assumed to be entirely adequate, and it was considered that it was the difference in the venous drainage which brought about the diminished rise in skin temperature to body heating. It was concluded that it was not only the amount of blood but also the time which the blood takes to flow through the subpapillary venous plexus and through the small veins which determines the ultimate skin temperature. During elevation there occurs a fall in venous pressure emptying the larger veins and a drainage of Wollheim's subpapillary venous plexus. The blood returns hastily through the collapsed veins, and there is no time for it to give off heat and transmit its temperature to the surrounding tissues. The reverse state of affairs will, of course, be true in the dependent limb. Despite the conclusive nature of these studies, reference is not always made to the limb position in studies on skin temperature.

Radiometry is technically an unsatisfactory method of measuring skin-temperature changes. Unless very fine wires are used when thermocouples are employed, the heat loss of the area of skin where they are applied will be seriously modified. Pressure of application can also give rise to errors.

One great disadvantage of skin-temperature measurements is the large thermal lag involved, and brief but large changes in the circulation cannot be recorded with accurate time relationships. To some extent this objection can be overcome in finger recordings (where the flow is almost exclusively to the skin) by using a surface thermo-stromuhr. In this method a constant small amount of heat is supplied and its dissipation through neighbouring skin measured. All the other factors mentioned above must, of course, still be controlled.

Calorimetric methods involving enclosing the finger in a vacuum flask and measuring the difference of temperature between the inflowing and outflowing water have been used (GREENFIELD and SHEPHERD, 1950). The method, however, contains certain errors connected with the lag caused by the thermal capacity of the finger varying with the change in blood-flow. Furthermore, BAZETT *et al.* (1948), who studied the variations in blood temperature by means of thermocouples inserted in various arteries and veins, have remarked: "Attention is drawn to the chaos introduced into physiology by the fictitious assumption of a constant blood temperature."

Plethysmographic Methods

Variations in the volume of the extremities or of part of the extremities have been studied since the middle of the seventeenth century, when JOHAN SWAMMERDAM studied the variations in the volume of isolated muscles during contraction, by direct observation of the movements of the surrounding liquid contained in a closed

container provided with a gauge. STURUP (1940) has provided a comprehensive historical review of the early plethysmographic methods, and GREEN (1948) has reviewed more recent work. Volume plethysmography has proved particularly useful in investigations on vasomotor response, and, combined with the venous occlusion procedure, has become a standard method for estimating the peripheral blood-flow in man (ABRAMSON, 1944; BARCROFT and SWAN, 1953). Although there have been many refinements in technique in recent years, the current procedure is still fundamentally the same as that used by the earlier workers. A limb or part of a limb is sealed in a rigid jacket so that volume changes of the enclosed part will cause corresponding volume displacements of the space between the limb and the jacket. The sealed space, filled with either water or air, is connected to a volume recorder by an air or water-line.

There now exists an extensive literature on the application of this technique, and some of the disadvantages and limitations have been discussed by LANSDOWNE and KATZ (1942). The sealing of the limb within the jacket may give rise to problems, for a perfect water or air-tight fit must be achieved without appreciable constriction of the tissues, especially during volume increases of the enclosed part. Furthermore, the fluid filling the chamber, maintained at a constant temperature, may induce local vasomotor changes. The apparatus tends to be cumbersome and restrictive to the patient, though the employment of electrical transmission (COOPER and KERSLAKE, 1951) in the case of the liquid-filled plethysmograph has enabled much of the recording apparatus to be removed from the proximity of the patient. WHITNEY (1953) has recently described an apparatus for measuring limb-volume changes which eliminates many of the objections of the conventional air or water-plethysmographs. The limb is surrounded by mercury-in-rubber strain gauges, and the volume changes are calculated from the electrical variations which occur as the result of resistance to the passage of current increasing as the fine mercury column is lengthened. A number of important technical objections have, however, been raised against this method (WHITNEY, 1954).

Finger or toe plethysmography has usually been carried out with a light cup of metal or glass enclosing the digit and an air transmission system. Volume changes have been recorded by photographing the movements of water in a capillary tube (GOETZ, 1933, 1935, 1948) or by photographing the movement of a beam of light reflected from a Franks capsule—a rubber diaphragm to which is attached a mirror (CARMICHAEL and co-workers, 1935-39; TURNER, 1937; BURCH, 1947). More recently, increased sensitivity of recording the volume changes has been made possible by the use of electronic capacity manometers (LOE, 1952; MELROSE, LYNN, RAINBOW, and WHERREL, 1954). HERTZMAN (1938) introduced a photoelectric plethysmograph which eliminated any danger of mechanical constriction of the finger. This transilluminated the finger and derived volume changes from the variations in the output of a photoelectric cell with each beat (HERTZMAN and DILLON, 1940a,b; HERTZMAN, RANDALL, and JOCHIM, 1946). It is, however, probable that this method measures something more complex than the volume pulsation of a digit.

The findings from limb plethysmography must be carefully distinguished from those of digit plethysmography, for whereas the bulk of the tissue under study in the former is muscle, in the finger and toes the blood supply is only to the skin.

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Muscle and skin circulatory responses may be quite different, as exampled by the action of adrenalin being dilator on the former and constrictor on the latter (REIN and SCHNEIDER, 1930; REIN, 1931; FRIEDLANDER, SILBERT, BIERMAN, and LASKEY, 1938; GRANT and PEARSON, 1938; ALLEN, BARCROFT, and EDHOLM, 1946). Combined plethysmographic studies have shown that the circulatory increase following heating is predominantly in the skin and following exercise predominantly in the blood vessels (KUNKEL, STEAD, and WEISS, 1939). These findings were later confirmed by HARRIS, MARTIN, and WILLIAMS (1952), using a radiosodium clearance technique. The blood-flow through the hand is regularly diminished in response to various stimuli, whereas that through the forearm is either unaffected, or generally increased (GRANT and PEARSON, 1938; ABRAMSON and FERRIS, 1940; WILKINS and EICHNA, 1941).

The venous occlusion technique applied to the limb or finger plethysmograph has become a standard method for studying the peripheral blood-flow. The blood-flow is calculated from the volume increase of the part occurring in unit time following the occlusion of the venous outflow. GOETZ and AMES (1949) have pointed out that the high pressure needed for complete venous occlusion has often not been fully appreciated. BURTON has recently cast grave doubt on the validity of the venous occlusion technique (GASKELL and BURTON, 1952; BURTON, 1954). He demonstrated that there is a decrease of volume of the blood vessels caused by the venous occlusion in the act of measurement. The effect of this artifact is likely to be greater when a high vasomotor tone or an increased venous pressure is present.

The relationship between changes in volume of a limb or part of a limb and changes in blood-flow is not a direct one. Whilst the arterioles chiefly control the flow of blood, the volume of blood they contain is smaller than that contained in the capillary and venous beds, and because of the relatively great distensibility of the veins, changes in venous pressure can produce large changes in total volume. However, the volume pulsation with each heartbeat bears a more direct relationship to the peripheral flow, provided that changes in venous pressure are avoided, for the latter can affect the height of the pulse amplitude. Increasing the venous pressure by lowering the part will cause a reduction in the amplitude of the pulse volume; and conversely elevating the part, causing the veins to be less distended, will cause an increase in amplitude, though in either case the flow may be relatively unaffected. (TURNER, BURCH, and SODEMAN, 1937; GOETZ, 1950; GASKELL and BURTON, 1952). However, when examination is carried out with the limb maintained at heart level, and variations in venous pressure are avoided, then there is a very close correlation between the amplitude of the finger-volume pulsation and the blood-flow of the finger (BURTON, 1939; MELROSE, LYNN, RAINBOW, and WHERRELL, 1954). Under these conditions, therefore, variations in the pulse amplitude can be used as a direct index of variations in the vasomotor tone of the skin arterioles.

Suitability of Method for Emotionally Disturbed Subjects

Although the thermal methods of recording are relatively simple in their application, some of the possible errors, as mentioned above, render them far from satisfactory on technical grounds. For use with emotionally disturbed patients, finger plethysmography appears to offer the most satisfactory compromise between simplicity of application and reliability of method. As only the cutaneous vascular

reactions are involved, the evaluation of the results is rendered less complex. Furthermore, as the innervation of the cutaneous vessels is entirely derived from the sympathetic nervous system, and no dilator nerve fibres are present in the skin (WARREN, WALTER, ROMANO, and STEAD, 1942; ARNOTT and MACFIE, 1948), variations in the pulse amplitude can furnish a valuable index of sympathetic response to emotional disturbance. However, for the latter to be at all significant, certain physiological factors influencing the peripheral vasomotor response must be taken into account. These will now be examined in more detail before any attempt is made to review the results obtained by previous workers in this field.

SOME PHYSIOLOGICAL FACTORS OF IMPORTANCE IN THE RECORDING OF PERIPHERAL VASOMOTOR RESPONSES

Nervous Pathways of the Vasomotor Response

The immediate cutaneous vasoconstriction which occurs following various physical and emotional stimuli is effected via the sympathetic nervous system. It does not occur in the sympathectomized limb. STURUP, BOLTON, WILLIAMS, and CARMICHAEL (1935), BOLTON, CARMICHAEL, and STURUP (1936), DOUPE, ROBERTSON, and CARMICHAEL (1937), MARQUIS and WILLIAMS (1938) studied the finger plethysmographic response in patients with subthalamic lesions of the sensory pathways and with thalamic and cerebral lesions. It was concluded that in man the ascending pathway for the vasomotor response to somatic stimulation is the spinothalamic tract, and that the vasomotor reflex arc is complete in the brain stem below the level of the sensory thalamus. WILLIAMS and SCOTT (1939) carried out similar studies on a girl who had had a complete hemi-decortication two years previously. The equality of the response from both sides of the body and from cutaneous stimulation of each side suggested that the reflex arcs used in these responses have no cortical cell station in man. This equality of the bilateral vasoconstrictor response had previously been demonstrated in the case of hemiplegia (STURUP, BOLTON, WILLIAMS, and CARMICHAEL, 1935; UPRUS, GAYLOR, WILLIAMS, and CARMICHAEL, 1935). The hypothalamus contains centres governing generalized vasoconstriction and vasodilatation, and the importance of cortical impulses in vasomotor phenomena is now recognized (CHAPMAN, LIVINGSTON, and LIVINGSTON, 1949; CHAPMAN, LIVINGSTON, and POPPEN, 1950; POOL and RANSAHOFF, 1949). The fact that a sympathectomized limb may exhibit delayed emotional vasoconstriction does not establish circulating adrenalin as an important cause of this phenomena in ordinary circumstances, as the sympathectomized limb is extremely hypersensitive to the action of adrenalin (FREEMAN, SMITHWICK, and WHITE, 1934). Furthermore, FATHEREE, and ALLEN (1938) found that the effect of adrenalin was not striking in patients with a history of emotional and acral vasoconstriction.

Volume Variations in the Plethysmographic Curve

With a subject resting quietly in a suitable environment, a number of more or less rhythmical fluctuations in the volume of the part, not apparently connected with external stimuli, may be observed.

Pulse waves. These are caused by the heartbeat, and their size is largely dependent on the degree of vascular dilatation. Their speed corresponds to the action of the heart and their shape is a combined product of central and peripheral conditions.

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In the normal subject at rest the size of the pulse-wave in the finger-tip varies from about 1 to 20 $mm^3/5$ cc of part. Many subjects may manifest intermittent constrictions of the pulse-wave, which may vary in frequency, degree and duration, but may at times be of a rhythmic character. These fluctuations appear to be commonest when the subject is relaxed or drowsy, and are greatest in the middle range of amplitude. It has been suggested that these waves are due to Traube Hering blood-pressure waves (SHEPARD, 1906, 1914), are fluctuations serving temperature control (INGRAM, 1936; BURTON, 1939), are "spontaneous" peripheral changes (ABRAMSON and KATZENSTEIN, 1941), or rhythmic variation in sympathetic tone in the relaxing subject (NEUMANN, LHAMON, and COHN, 1944). However, combined E.E.G. and plethysmographic studies by ACKNER and PAMPIGLIONE (1955) indicate that many of these so-called "spontaneous" fluctuations are reflections of variations in level of alertness which are not appreciated by the subject.

Finger-volume deflections. Volume changes of the finger, named alpha deflections by BURCH, COHN, and NEUMANN (1942a), may vary in size from about 15 to 80 $mm^3/5$ cc of part. They are not uniform in any fashion, though decreases usually occur in one long rapid deflection and increases take place slowly or in steps. The deflections do not depend on variations in arterial pressure (NEUMANN, 1943), and they are abolished almost entirely by sympathectomy. Their occurrence appears to be related to changes in the arterial inflow, for they usually occur concurrently with pulse-amplitude variations, and the direction of the deflection is concordant with the latter.

Respiratory deflections. Small rhythmic variations in finger volume may occur synchronously with the respiratory cycle. They do not occur in all subjects, and may occur in a subject on one occasion and not on another. They are perhaps related to the small fluctuations in venous pressure which occur with respiration, and are to be distinguished from the vasoconstriction which occurs after a deep inspiration. This latter change is considered in more detail below.

Respiratory vasomotor responses. Apart from the small waves of rhythmical fluctuations in volume synchronous with respiration mentioned above, another type of response may be observed related to the respiratory cycle. A deep inspiration may be followed by a reduction in both the pulse and finger volume with a latency of about 3 sec. This vasoconstrictor response is most marked following a spontaneous deep inspiration, especially of a sighing type. The response may not always follow a deep voluntary inspiration and, when it does, repetition of deep inspiration tends to reduce the response until it is finally extinguished. BOLTON, CARMICHAEL, and STURUP (1936) demonstrated that this respiratory vasoconstrictor response occurred only in a limb with an intact sympathectic supply. They argued that, as the response does not follow abdominal inspiration and occurs only after a deep thoracic inspiration, it must depend on afferent stimuli arising from expansion of the chest-wall. However, as recent work (WADE, 1954) has demonstrated that voluntary "abdominal inspiration" is only apparent and never accompanied by concomitant diaphragmatic movement, this explanation is rendered doubtful.

Vasomotor Reactivity to Stimuli

The pulse and finger volume decrease, following an adequate acute stimulus such as noise, light, pain, a threat, a difficult arithmetic problem, etc. (STURUP, BOLTON,

WILLIAMS, and CARMICHAEL, 1935). The decrease in volume is bilaterally synchronous and occurs with a latent period of about 3 sec whatever effective stimulus is employed. BURCH, COHN, and NEUMANN (1942b) have claimed that the reactivity in senile patients is slightly longer in duration, and in hypertensives slightly shorter, than that in normal subjects. The size of the volume reduction following a stimulus is partly related to the degree of dilatation present at the time of the stimulus. No reflex constriction can be expected if the vessels are not dilated beforehand. The duration of the response varies considerably, and is related, as is also the size, to the intensity of the stimulus and its significance to the individual.

The Influence of Temperature Changes

Increase or decrease of blood-flow through the skin can result respectively in loss or conservation of bodily heat. Skin blood-flow is, therefore, affected by metabolic changes, and by external environmental temperature. The changes are most marked in the exposed extremities, which are favourably placed to act as radiators or conservors of bodily heat.

Skin temperature rises steadily through the day, reaching its peak at about 9 p.m., and dropping throughout the night (HEISER and COHEN, 1933). Digestion and muscular activity are probably important factors in causing diurnal variations (ROTH and SHEARD, 1950). The normal ranges of humidity have little effect on the skin temperature (TALBOT, 1931). The warmer the surrounding temperature the more does the temperature of the extremities approximate to that of the rest of the body. With an external temperature below 20°C, the exposed extremities will be lower in temperature than the rest and will show fluctuations in temperature. Below this temperature, skin vasoconstriction prevents cooling of the body by the environment. As the temperature of the environment rises above 20°C, variation of the temperature of the extremities tends to become smaller, the temperature of the toes becoming stable at a lower environmental temperature than that of the fingers (REDISCH, SHECKMAN, and STEELE, 1952). At about 25°C the surface of the body is fairly constant and uniform (BENEDICT, 1925; BENEDICT and PARMENTER, 1929; STEELE, 1934). This would appear to depend on the fact that the temperature of the extremities, under these conditions, does not at any time fall below that of the trunk, and they are then constantly occupied in radiating heat.

The skin vessels of the extremities dilate when the body is suitably warmed, for instance by placing the feet of the subject in hot water. Vasodilatation by this means has been used by many workers in the study of functional and organic peripheral vascular disorders. It has been claimed (GOETZ and AMES, 1949) that reflex vasodilatation by heating the extremities is dependent on the return of the heated blood, which acts on the thermosensitive centre in the hypothalamus, and that the mechanism is not nervous in origin, as has been alleged by some workers. Some apparently healthy subjects are very cold-sensitive, and they only produce full vasodilatation after heating, after the body temperature itself has risen (GRAYSON, 1951).

The Influence of Limb Position

Reference has already been made to changes in skin temperature and in volume of the extremities produced by changes in posture. GOETZ (1950) and GASKELL and BURTON (1952) have shown the importance of limb position in the evaluation

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of the plethysmographic curve. It was found that, when the limb is elevated, the pulse is larger, the dicrotic notch is less or absent, the finger volume is smaller, and the changes in finger volume, both spontaneous and elicited, are more marked. In the dependent limb or with venous obstruction the changes are in the opposite direction to those above, and accessory waves in the pulse may occur. These changes are manifest with change of position in both the upper and lower limbs, and occur in the sympathectomized limb. These findings are accounted for by variations in the distensibility of the veins due to the alterations in venous pressure caused by the postural changes. When examination is carried out with the limb maintained at heart level, and variations in venous pressure are avoided, then there is a very close correlation between the amplitude of the finger-volume pulsation and the blood-flow of the finger (BURTON, 1939; MELROSE, LYNN, RAINBOW, and WHERRELL, 1954).

The Influence of Blood-pressure Changes

Diurnal variations in surface temperature of the skin regularly occur in individuals with arterial hypertension without significant change in systemic arterial pressure (STEELE and KIRK, 1934). Stimuli causing a rise in blood pressure regularly diminish the blood-flow through the hand, as measured by venous occlusion plethysmography, whereas the blood-flow through the forearm is either unaffected or generally increased (ABRAMSON and FERRIS, 1940). Blood-pressure and pulse-volume changes in the finger appear to be in opposite directions except in the sympathectomized limb (BURTON, 1939). Variations in the volume of the finger-tip usually go on independently of changes or of lack of change in blood pressure (NEUMANN, 1943). Traube Hering waves of blood-pressure change are accompanied by changes in finger volume in the upright but not in the recumbent subject (MATTHES, 1952).

It seems that rise in blood pressure may result in dilatation of the larger vessels of the limbs as a result of passive distension of their non-muscular walls. However, in the small skin arterioles with intact sympathetic supply, not only is the muscular tone of the vessel wall adequate to prevent any distension by a rise in blood pressure but, in fact, a rise of blood pressure is often associated with vasoconstriction. Plainly this vasoconstriction is not a physical result of the rise of blood pressure, but is an independent response to the stimulus which itself is causing a rise in blood pressure. The skin vasoconstriction, in fact, probably contributes to a small extent to the increase in peripheral resistance which causes a rise in blood pressure. In contrast to the limb plethysmograph, therefore, blood-pressure changes do not appear to be of much significance in evaluating changes observed in the finger plethysmograph.

The influence of venous-pressure changes. Reference has already been made to the influence of the venous pressure on the pulse- and finger-volume changes. CAPPS (1936) applied a cuff to the wrist and raised the venous pressure to 70 mm Hg, thereby preventing venous constriction without materially affecting arterial inflow. He found that, under these conditions, a pinch did not produce the usual decrease in hand volume, and claimed that this indicated that the normal reflex decrease in hand volume was due to the constriction of the veins, venules, and capillaries. However, it is known that once a stimulus has been applied (in this case the inflation of the occlusive cuff), and the subject is under stress, a further stimulus may cause little if no response. In fact, ABRAMSON and FERRIS (1940) found that a strong noxious stimulus would, under the above conditions, cause a reduction in hand volume.

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ABRAMSON and KATZENSTEIN (1941) found that raising the venous pressure to 70 mm Hg consistently caused the "spontaneous" volume variations of the hand to disappear, and concluded from this that the latter changes were largely the result of alterations in the calibre of the venous bed. However, it is known that these spontaneous variations only occur in the relaxed subject at rest, and the stimulation from the effects of the occlusive cuff itself is enough to cause them to disappear. The claims made by BURCH (1954) for the participation of the venous bed are rendered somewhat doubtful by the demonstration by GASKELL and BURTON (1952) and BURTON (1954) of the artifact involved in the venous occlusive technique.

It is probable that, to a large extent, the volume pulsation of a digit originates in the capillaries and veins rather than in the arterioles. However, with the arm at heart level and the subject recumbent, breathing normally, and not exposed to cold conditions, the venous pressure and arteriovenous shunts (GRANT, 1930; GRANT and PEARSON, 1938; CLARK, 1938) probably have little influence on the height of the pulse amplitude, which can be considered to reflect directly the arterial patency (BARCROFT, 1954).

The Influence of Sleep

Sleep has been shown to be preceded and accompanied by a rise in skin temperature (UHLENBRUCK, 1924; KIRK, 1931), and abnormal vasomotor tone in acrocyanosis has been shown to be released during sleep (DAY and KLINGMAN, 1939). MAGNUSSEN in a series of studies (1939, 1943, 1944) investigated changes during sleep by means of skin temperature, and later by plethysmographic studies. The onset of sleep was found to be associated with an increasing vasodilatation, maximum at the beginning of the sleep period and replaced then by a slight tendency to vasoconstriction. MAGNUSSEN considered vasodilatation to be one of the functional changes in the various phases of sleep preparedness during which there is reduced sympathetic activity. It seems likely, however, that the experimental conditions under which these studies were carried out may have been quite anxiety-provoking. An emotional vasoconstrictor factor, later released in sleep, therefore, may have been present. Furthermore, the influence of the external environmental temperature appears to have been an important factor. It has been shown (STEELE, 1934) that the rise in temperature of the extremities associated with drowsiness and falling asleep only occurred regularly if the external environment was below 22°C, and MAGNUSSEN himself admits (1943) that "in order to produce the possibility of variations in the skin temperature required for sleep preparedness, it is essential that the external environment should be *below* this figure" (20–22°C). The influence of sleep on the pulse volume will be considered in detail during the discussion on the experimental findings in a later paper.

PREVIOUS WORK ON THE INFLUENCE OF EMOTIONAL FACTORS ON THE PERIPHERAL VASOMOTOR SYSTEM

The influence of various stimuli on variations in volume of the extremities was first clearly demonstrated by the systematic investigations of MOSSO (1881). Results in arm plethysmography have been variable. Increase and decrease in volume have both been reported for pleasant, unpleasant, startle, and attention stimuli. In recent years, many investigators have studied the effect of various stimuli on the finger

plethysmograph (DARROW, 1929; STURUP, BOLTON, WILLIAMS, and CARMICHAEL, 1935; STURUP, 1935; CARMICHAEL, DOUPE, HARPER, and MCSWINEY, 1939; STURUP, 1940; HERTZMAN and DILLON, 1940; BURCH, COHN, and NEUMANN, 1942; ELTHORN, PIERCY, and CROSSKEY, 1951). Only a decrease in volume has been reported following acute stimuli of all types, both sensory and "psychical." Numerous stimuli have been used, including cold, heat, pinching, pricking, electrical shock, light, noise, a threat, difficult arithmetical problems, etc. The question arises as to what is the feature common to all these stimuli producing the vasoconstrictor responses.

HALLION and COMTE (1895) demonstrated a decreasing plethysmographic reaction to a series of faradic stimuli. Since then many investigators have confirmed this decreasing reaction to continued repetition of the same stimulus. This has also been repeatedly demonstrated for the psychogalvanic reflex. It is apparent that, with sensory stimuli, sensation *per se* is not the cause of the vasoconstrictor response. A cold stimulus does not maintain vasoconstriction, though it may be continuously recognized as cold. Repeated pain stimuli similarly decrease in their effectiveness. Repetition of the stimulus is still experienced as pain, often with increasing discomfort, but the reaction decreases in strength and may be unobtainable after a number of repetitions. The reaction may be restored by changing the site of the stimulus, and this may be why MARQUIS and WILLIAMS (1938) found that the size of the plethysmographic curve response is proportional to the stimulus. The stimuli in their experiments were given in a predetermined random order at various points on the body in order to avoid any marked adaptation effect.

DOUPE, MILLER, and KELLER (1939) investigated the finger plethysmographic response to the stimulation of hypnotically anaesthetized limbs. They found that strong pin-pricks on the hypnotically analgesic side produced smaller vasomotor response than that on the normal side. They considered that this was due to the loss of feeling tone normally associated with the awareness of the stimulus.

Commonly the threat of a painful stimulus will produce a vasoconstrictor response as great as, if not greater than, the subsequent response produced by the stimulus itself. This reaction also disappears rapidly on repetition. An arithemetical problem, such as the subtraction of a two-figure number, generally produces a marked vasoconstrictor response. But, if the same figures are repeated and the subject is not asked to subtract them, no change in volume is observed. Though the effort of concentration commonly evokes a vasoconstrictor response, such a response occurs during concentration that is not emotionally coloured.

It would appear that the factor common to all the stimuli capable of evoking a vasoconstrictor response is the capacity of the stimulus to arouse the immediate attention of the individual. Once this arousal has occurred, further stimuli prove decreasingly effective. But it is not necessarily the conscious attention of the individual which has to be aroused, for the reaction is present in the absence of consciousness. MOSSO's (1881) early assertion that the plethysmographic reaction to noise, cold, heat, etc., is maintained during sleep was confirmed by other workers (HALLION and COMTE, 1894; HOWELL, 1997; BRODMAN, 1902; BERGER, 1904; SHEPARD, 1906, 1914; WIERSMA, 1916; UHLENBRUCK, 1924), though in recent years little attempt has been made to pursue the significance of this. However, work now being undertaken by ACKNER and PAMPIGLIONE (1955) indicates how sensitive is a stimulus at a

depth of sleep at which other bodily reactions, such as skin resistance, respiration, and heart rate, fail to respond by any change. Furthermore, even during sleep, stimuli will vary in their effectiveness according to their nature and significance to the individual; and adaptation, although occurring much more slowly than during the waking state, still occurs.

It thus appears that the vasoconstrictor response is part of an arousal or alerting reaction to a new stimulus situation. Stimuli which are emotionally significant to the individual are likely to prove more effective than those which are not so charged. Neither the process of "psychic" selection which evaluates the significance of the stimulus, nor the capacity for the vasoconstrictor response itself, is dependent on consciousness. It is to be expected, then, that emotional factors, to be effective, do not necessarily have to be within the conscious awareness of the individual.

PREVIOUS WORK ON THE RELATIONSHIP OF EMOTIONALLY DETERMINED PERIPHERAL VASOMOTOR RESPONSES TO VARIOUS BODILY DISORDERS

MITTLEMAN and WOLFF (1939) studied the finger-temperature variations in patients in whom emotional stress was induced at interview. During sustained stress, the finger temperature of some individuals remained continuously close to that of the environment, with associated "cold hands." In a patient with Reynaud's syndrome, induced emotional stress precipitated attacks of pain and cyanosis in a temperature environment which itself produced no attacks. In subjects with "cold hands" or with Reynaud's syndrome, the degree of discomfort appeared to be the resultant of the interplay between factors of emotional stress and environmental temperature. MITTLEMAN and WOLFF (1942) studied finger-temperature changes together with changes in gastric notility and acidity. Finger temperatures fell in about two-thirds of the subjects in whom there were induced emotional changes in interview associated with increased gastric secretion and peristaltic activity. The changes did not always follow changes in gastro-duodenal function, and in one interview an inverse relationship was noticed, a drop in skin temperature being associated with apparent relaxation of the patient.

OSBORNE and COWEN (1945) showed that men with a previous history of excessive vasomotor reaction to emotion are markedly susceptible to frostbite and trenchfoot.

GRAHAM (1950) claimed that measures of skin temperature and capillary tone showed that hives (urticaria and angioneurotic oedema) induced by emotional stress was preceded by a rise in skin temperature and a low capillary tone. The latter findings were interpreted as indicating vasodilatation of the arterioles and capillaries.

NAIDO, SAYEN, and COMROE (1945) studied the digital temperature responses to heating and cooling in a group of rheumatoid-arthritis patients. They concluded from their findings that the peripheral vessels were easily constricted, and considered that the high vascular tone might be one of the basic factors in the flare-ups of the condition after emotional upsets and exposure to cold.

DEUTSCH (1952) carried out finger plethysmographic studies during interview in a patient affected by dermatitis of the hand. It was claimed that there was an increased vasoconstrictor response to emotionally charged topics in the hand affected, compared to the other side. In view of the inadequate technique employed, the reliability of these results is doubtful.

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PERIPHERAL VASOMOTOR RESPONSES IN MENTAL DISORDERS

Psychoses

The presence of cold blue extremities in chronic psychotic patients has long been noted by workers in mental hospitals. The majority of such patients are suffering from the catatonic form of schizophrenia, though the acrocyanotic disorder may be observed in other varieties of chronic psychosis (STERN, 1937) and the peripheral blood-flow has been shown often to be reduced in manic-depressive psychosis (ABRAMSON, SCHKLOVEN, and KATZENSTEIN, 1941).

Workers who have studied the skin-temperature responses of schizophrenic subjects have all reported excessive drop in skin temperature to external cooling; and usually a normal, though sometimes delayed, response to heating (CAMERON, 1934; STERN, 1937; FREEMAN, 1939; FREEMAN, 1940; SHATTOCK, 1950). Skin-temperature responses have been reported to be normal after the administration of dibenamine (MEDINETZ, KLEIN, and METTLER, 1948) and carbon dioxide (ALTSCHULE and SULZBACH, 1949).

JUNG and CARMICHAEL (1937) studied the finger plethysmographic responses of a group of akinetic catatonics. They demonstrated an excessive vasoconstriction and diminished blood-flow, but found that vasodilation with heating was normal in degree though sometimes delayed. Provided that adequate initial dilatation was secured, various stimuli and the administration of adrenalin resulted in normal vasoconstrictor responses. The inability of initially contracted vessels to respond to further vasoconstrictor stimuli, together with the difficulty in securing the attention of the withdrawn schizophrenic, probably accounts for reports of failure by some workers to obtain normal vasoconstrictor responses. The above plethysmographic findings in schizophrenic patients were later confirmed by ABRAMSON, SCHKLOVEN, and KATZENSTEIN (1941), ABRAMSON (1944), and HENSCHEL, BROZEK, and KEYS (1951).

The excessive peripheral vasoconstriction manifested by schizophrenic subjects does not appear to be the consequence of emotional disturbance, and, indeed, it is observed most commonly by those subjects who are withdrawn and manifest little emotional disturbance. All the evidence indicates that it is part of the normal physiological mechanism for preserving body-heat. JUNG and CARMICHAEL (1937) confirmed the earlier findings of CAMERON (1934) that heat production was low in catatonic schizophrenics and that their heat regulation was very sensitive to cold. The catatonic schizophrenic is indifferent to discomfort and will neglect normal protections against cold conditions. The factor of immobility must also be taken into account, for immobilization of a limb for long periods will result in a fall in surface temperature under certain conditions. The simultaneous clearing of vasospasm and stupor which has been observed is probably the result of increased bodily activity associated with the end of stupor. SHATTOCK (1950), in a recent review of the peripheral vascular disturbance in chronic schizophrenics, concluded that prolonged vasoconstriction is necessary to conserve body-heat, owing to the failure to respond to increased bodily requirements during chilling and muscular exercise by adequate rises in metabolic level.

Emotional Instability and Neuroses

Since the early plethysmographic studies of HALLION and COMTE (1894, 1895) it has been recognized that emotional disturbance, especially in neurotic patients, is

productive of excessive peripheral vasoconstriction. In recent years, with refinements of technique, attempts have been made to study quantitatively the plethysmographic changes associated with emotional states. NEUMANN, COHN, and BURCH (1942) altered the character of the examining-room to make it more like a bedroom and less like a laboratory. The senile, hypertensive, and normal subjects studied plethysmographically by them reported that they felt more comfortable and less under experimental tension. When tested under these conditions it was found that there was an increase in the size of the pulse-volume and amplitude of the spontaneous finger-volume fluctuations compared to the findings when these subjects were tested under laboratory conditions. BURCH, COHN, and NEUMANN (1942) studied the spontaneous variations in the finger volume in a group of normal subjects. They claimed that those subjects who showed relatively small deflections which varied little in size appeared to be phlegmatic and emotionally stable. On the other hand, subjects showing a wide spread in the size of the deflections, many of which were large, appeared to be excitable, and exhibited wide fluctuations in mood. NEUMANN, LHAMON, and COHN (1944), using the same quantitative technique, studied a group of colleagues who subsequently reported subjectively on their emotional state during the testing period. Records which manifested a combination of large pulse-waves and small finger-volume fluctuations were only found in subjects in a state of full relaxation and contentment. Small pulse-waves together with small finger-volume fluctuations were found when anxiety was dominant. With less anxiety or with elation or resentment present, records containing large finger-volume fluctuations with varying size of pulse-waves were obtained. No uniform pattern was found with depression. LHAMON (1949) studied eleven patients whose finger plethysmographs showed large finger-volume fluctuations, with gross abrupt changes in pulse amplitude giving a paroxysmal and disorderly appearance to the records. All these patients were subject to emotional outbursts accompanied by disturbances in thinking or impulsive behaviour. In ten, the E.E.G. responses to hyperventilation were abnormal, and eight had excess slow-wave activity without hyperventilation. No correlation with diagnosis was found. The validity of these findings appears somewhat doubtful, for the two records given as examples strongly suggest that some of the gross deflections were movement artifacts. It is a fact that psychopathic subjects, who are often restless and muscularly tense, find it difficult to maintain a constant posture for any length of time, and movement artifacts are common in these subjects.

A further attempt to quantify the relationship between emotional disturbance and the finger plethysmographic response was made by VAN DER MERWE and THERON (1947) and THERON (1948). Student subjects were first given the Bell Adjustment Inventory, and a factorial analysis of the scores was carried out. This yielded two factors which were identified as "emotional stability-lability" and "basic emotional tension." The finger plethysmographic responses were then studied under controlled conditions with the other hand kept in a hot-water bath at 40°C in order to maintain vasodilatation. During the recording the subjects carried out a deep-breathing test and a cold-water test, and they were given mental arithmetic problems to solve. The results were then examined statistically in relation to the emotional factors derived from the Bell Adjustment Inventory. It was found that the "emotional stability-lability" factor was well correlated with the rate of change in finger volume

with the tasks, labile subjects tending to have a greater rate of change. The "basic emotional tension" factor was well correlated with the size of the pulse volume before the various tasks, the more "tense" subjects tending to have smaller pulse volumes.

VAN DER MERWE (1948) carried out the above procedure utilizing neurotic subjects whom he divided into a group of anxiety patients and a group of hysteria and neurasthenic patients. A control group had pulse volumes varying from 0·001 cc to 0·025 cc, with a mean volume of 0·007 cc. The pulse volumes of the anxiety group varied from 0·001 cc to 0·006 cc, with a mean value of 0·004 cc. The hysteric group had pulse volumes varying from 0·06 cc to 0·020 cc, with a mean value of 0·013 cc (per 5 cc of finger-tip). Considerable overlap was found in the assessment of the "basic emotional tension" of the groups, and this overlap was even greater in the assessment of the "emotional lability stability." However, the tendency emerged for the anxiety group, who were clinically more tense, to have smaller pulse volumes than the controls, and the hysterics to have larger pulse volumes.

The above experiments are of some importance, as they represent the only serious attempts which have been made to quantify the relationship between peripheral vasoconstriction and emotional disturbance. Certain observations must, however, be made on the validity of these findings. No indication was given that the time of day during testing was comparable, that the activities of the subjects prior to testing were controlled, or that repeat reliabilities were carried out. The method of obtaining vasodilatation by placing both hands in a hot-water bath and then later removing one for finger plethysmography must be considered unreliable. Furthermore, the division of the neurotic subjects into an anxiety and an hysteric group is not convincing on the clinical descriptions given. Finally, it must be emphasized again that the results which showed a greater peripheral vasoconstriction for the anxiety subjects represent a statistical finding for a group, and that the overlap present does not allow of the separation of the anxiety subject from the others on the basis of the absolute pulse-volume.

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SUMMARY

Techniques suitable for emotionally disturbed subjects have been examined, and various physiological factors relevant to recording peripheral vasomotor responses considered. The significance of the emotionally determined vasoconstrictor response has been discussed and its relationship to various bodily disorders reviewed. Previous work on peripheral vasomotor responses in mental disorder has been reviewed, with special reference to attempts to quantify the relationship between emotional disturbance and peripheral vasoconstriction. The quantification of this relationship will be further considered in a subsequent paper.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 21 to 48. Pergamon Press Ltd., London

THE RELATIONSHIP BETWEEN ANXIETY AND THE LEVEL OF PERIPHERAL VASOMOTOR ACTIVITY

AN EXPERIMENTAL STUDY

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INTRODUCTION

"THE problem that plagues the cardiologist arises from the fact that he sees evidence daily of the influence of emotion on the circulation, but has at hand no extensive body of physiologic data that might illuminate his clinical observations. For the most part, the psychosomatic studies of the circulation merely emphasize what the competent internist appreciates, namely that emotion may cause cardiovascular symptoms" (ALTSCHULE, 1951).

That the influence of emotion on the circulation has been extensively described but inadequately assessed perhaps derives, to a large extent, from difficulties which are common to all attempts to correlate mental states with bodily changes. It is difficult to characterize exactly the feelings experienced by subjects, nor is there any certainty that such feelings as they describe retrospectively may have been present at the time of examination. Authorities are in disagreement on the relative importance of conscious emotion as against unconscious drives and the objective criteria for determining the latter are absent. Disturbed mental states can be experimentally produced but are difficult to reproduce, and certainly do not bear of accurate comparison from one individual to another. Subjects can be exposed to comparable stimuli or environmental factors, but the emotional significance of a given factor to the individual determines the occurrence and to a large extent the severity of the bodily response to it. Stress is not something external which can be applied, for its occurrence depends on factors of emotional reaction inherent within the individual. Stress cannot thus be quantified; only the external factors producing it can be defined. Nevertheless, a number of studies of bodily reactions make the erroneous assumption of the equivalence of the emotional significance of the so-called standard or comparable stress situations utilized, and invalidly claim the differences in response to be due to variations in tissue or organ responsiveness.

To the many imponderables of psychological origin must be added those derived from the complexity of circulatory physiology. The circulation may be influenced by many factors, including variations in heart-rate and output, changes in arterial and venous pressure, respiratory irregularities, alterations in metabolism, the need for temperature regulation, and changes in posture. If the effects of emotion on the circulation are to be studied accurately, many of the above factors must be held constant, and to attempt this adequately may severely restrict the scope of the investigation.

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There is no disagreement as to the importance of emotional factors in causing circulatory changes. But the problem of how important such factors are is one which it is difficult to answer quantitatively and accurately. It was the aim of the present investigation to select an aspect of the peripheral circulation both convenient and profitable to study, and to devise suitable experimental conditions for the quantitative study of the relationship between emotional disturbance and the peripheral vasomotor response.

OBJECT OF PRESENT STUDY

A previous paper (ACKNER, 1956) has reviewed earlier work on the relationship between emotional factors and peripheral vasomotor responses. Alerting stimuli have been shown to have a peripheral vasoconstrictor effect and emotionally disturbed subjects tend to manifest a relative peripheral vasoconstriction. Emotionally disturbed subjects tend to have smaller finger plethysmographic resting pulse volumes than relaxed subjects, but the tendency is only a statistical one and the overlap is such that the absolute pulse volume cannot be usefully used to differentiate between emotionally disturbed and relaxed individuals. This is to be expected, having regard to the many factors, other than emotional, discussed above, which influence the final size of the peripheral pulse volume. The size of the pulse volume is the resultant of a number of constitutional and physiological factors, of which the emotional factor, if present, will be only one against many. It follows, therefore, that the absolute size of the pulse volume can give no indication as to whether it has been reduced from a higher level by an emotional vasoconstrictor factor. If, however, emotional disturbances could be removed, then any vasoconstrictor tendencies due to the latter would be abolished, with resulting increase in the size of the pulse volume. It would follow that, if conditions could be obtained in which emotional factors could reasonably be assumed to be absent or considerably reduced, then vasodilatation could be anticipated in emotionally disturbed subjects. Under these conditions, however, relaxed subjects, lacking an emotional vasoconstrictor factor, should manifest little change in the size of their pulse volume. Thus, rather than vasoconstriction, the tendency to vasodilatation might be found, under suitable conditions, to be a more accurate means of differentiating between emotionally disturbed and relaxed subjects.

After examining a number of alternatives, it was finally decided that sleep was the most suitable state in which to compare subjects, and during which it could reasonably be assumed that they were relaxed, and that emotional factors previously present were absent or considerably reduced. But in order to compare the effect of sleep on pulse volume, other physiological factors must be kept as constant as possible. Earlier workers (STEELE, 1934; MAGNUSSEN, 1943) have shown that with an environmental temperature below 20–22°, sleep is usually accompanied by a peripheral vasodilatation, but if the external temperature is kept above this figure, little or no such vasodilatation occurs. A temperature above 22°C would, therefore, need to be maintained during the experimental period. To be in a comparable physiological state it would also be necessary for the subject to have been exposed to minimal physical and metabolic demands prior to testing. For this reason it was decided that natural sleep occurring at the end of a day would be unsuitable, being preceded by unknown factors of emotional stress, physical exertion, digestion, and external temperature. Sleep occurring early in the morning, a fixed period after a light breakfast and preceded by

resting conditions, appeared to be more desirable, but inevitably there would be difficulty in achieving sleep at this time of day. A study of the literature revealed no evidence that barbiturates, as such, caused vasodilatation. Preliminary experiments revealed that relaxed subjects given short-acting barbiturates did not vasodilate whilst awake. It was decided to use Seconal as a sleep-producing agent, since that drug is not only reliable and rapid in action, but E.E.G. studies have shown that sleep so produced is more akin to natural sleep than that produced by other barbiturates.

The hypothesis then to be tested was that, under suitable experimental conditions, sleep induced by Seconal in the morning should result in an increase in the finger plethysmographic pulse volume in manifestly anxious subjects, but little or no change in those who were relaxed.

METHODS

Recording Methods

A Hughes 7-pen direct ink-writing unit was modified for recording purposes. An extra pen was added for a signal-marker and the other seven pens were used to record (1) time in one-second units, (2), (3), and (4) three E.E.G. channels, (5) respiration, (6) pulse volume, and (7) finger volume.

An Evershed and Vignoles 1-ma recorder was mounted above the 7-pen block with its pen 2 cm in front of the other pens and able to traverse the whole extent of the paper. This pen was used to record variations in the palmar skin resistance.

The paper used was standard 6-in. E.E.G. paper, and the paper drive was geared to enable the paper to be run at 1 mm, 4 mm, 8 mm, or 16 mm per second as required.

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Plethysmograph

The plethysmograph used was a modification of the electronic apparatus described by Loe (1952). This had the advantage of being sensitive, simple to construct and not requiring a transducer valve (then in short supply). It was essentially a capacity manometer utilizing a circuit originally described by Alexander (1951) for the purpose of the measurement of small changes in length.

The circuit makes use of a characteristic peculiar to the octode class of multi-electrode valve, and is an effect which is unwanted when the valve is used as a normal electron-coupled frequency changer. The characteristic in question is that of the change which occurs in the average anode current or voltage when the resonant frequencies of two oscillatory circuits, connected to certain of the valve grids, are separated progressively from a common valve.

The manometer itself consists of a tambour with a corrugated annealed barillium-copper diaphragm approximately 3 in. in diameter and 0·003 in. thick. This forms one plate of a condenser and the other plate about $\frac{7}{8}$ in. in diameter can be screwed towards or away from the diaphragm for initial sensitivity adjustment. There exists a capacity of a few picofarads varying with the changes in pressure consequent upon volume changes in the finger-tip. This variable capacity is coupled in the EK-32 oscillatory circuit.

The volume changes in the finger-tip are transmitted to the manometer as varying changes of pressure within an enclosed air system with a small fixed capacity. This system consists of the glass cup, which fits snugly over the end of the terminal phalanx, together with about 3 ft of plastic tubing, of 1 mm inside diameter, leading from the end of the cup to the tambour. Cups of varying sizes of orifice are available to ensure a good fit, and an air-tight seal is achieved by the application of vaseline. A three-way tap is inserted in the air line, so that the air system of the tambour can either be in direct communication with the air, with the volume changes of the finger-tip, or can be shut off from either.

Pulse volume is indicated on a 2-in. C.R. tube via an R.C. coupled amplifier which is also coupled to the recording pen. Gross finger-volume changes are indicated on a centre-zero 1-ma meter with an amplifier supplying pulses to a marker pen whose interval varies directly with variations in gross finger volume. Calibration is carried out with the aid of a graduated pipette reading in mm^3. This is inserted into the air system and can be filled with mercury by a screw arrangement compressing rubber tubing in the manner of a Warburg manometer. This makes it possible to increase or reduce the volume of the air system by a known amount, so enabling the calibration of the meter and pen

deflections. Sensitivities are so adjusted that the gross finger volume changes are indicated on the meter reading from -70 mm^3 to $+70$ mm^3, these deflections corresponding to known "pip intervals" on the recording pen. In a similar manner adjustments are made so that a pulse volume-change of 1 mm^3 causes a deflection of 1 mm of the pulse pen. Pulse volume can thus be read directly from the paper recording without any further calculation. The separation of the pulse-volume and the finger-volume changes and their recording on two separate pens has great advantages when particular attention is being paid to the accurate measurement of the pulse-volume amplitude. Recording on a single pen always results in the slower finger-volume changes constantly altering the base line and distorting the appearance of the pulse-volume changes. The utilization of different time constants in the present methods allows the pulse-volume changes to be distinguished easily from the finger-volume changes with which they are often associated.

The H.T. supply is stabilized and, after a warming-up period of half an hour, the drift due to heating of the air system is negligible. The output response is linear over a volume change ± 50 mm^3. When this is exceeded it is necessary to equalize the pressure by opening the system to air by means of the three-way tap. At the beginning of each testing day, after a period of warming up, the tuning of the oscillatory circuits is tested and adjusted if necessary. Sensitivity calibrations are carried out at regular intervals.

Prior to the cup being applied to the digit, the volume of the digit is estimated by the water displacement method as described by BURCH (1947). The subject then lies on the bed with the left arm supported so that the arm remains at heart level. The plethysmographic cup is then applied just distal to the crease between the distal and middle phalanx of the digit, and sealed with vaseline. Before recording begins, testing is carried out for air-leaks and sensitivities are adjusted.

Measurement of Skin-resistance

The apparatus used was based on the bridge circuit described by HILL *et al.* (1951). The electrodes used were a flat copper disc the size of a penny, pressed uniformly in the palm of the right hand, and a plate strapped above the right wrist after the latter had been treated with abrasive electrode jelly. The latter electrode acted also as a common earth for the electroencephalogram. The range of resistance up to one megohm was divided into a number of smaller ranges, selected by a switch. Calibration was carried out by means of a number of "dummy" resistances of known amount. These could be selected by another switch, the sensitivity of the pen being adjusted for suitable resistance ranges. During the recordings, fixed resistance levels were marked at regular intervals on the paper to provide a base line.

Respiration Recordings

Respiration was recorded by a slight modification (ACKNER, 1955) of the method described by WADE (1954). This utilized a mercury-in-rubber strain gauge to form the variable resistance in the two limbs of a conventional bridge circuit. Special rubber tubing (supplied by Dunlop Special Products) was used. This was about 18 in. in length with about a 0·5-mm bore, and walls 1·5 mm thick. The mercury-filled tubing, after being stretched and tied round the chest, was hardly noticeable by the subject. With each inspiration and expiration the fine mercury column was respectively lengthened and shortened, with accompanying increase and decrease in the electrical resistance. The electrical changes were amplified, and activated the recording pen. The resulting curves were an accurate representation of respiratory rate and rhythm but, for various reasons, gave a qualitative but not quantitative picture of changes in respiratory amplitude.

Electroencephalographic recordings were taken with a 3-channel amplifier, utilizing electrodes placed on the frontal, central, parietal, and occipital areas of the left side of the head. The general procedure was that of a standard E.E.G. recording.

SUBJECTS

Three groups of subjects were used:—

(a) *Anxiety group*—The subjects in this group were all psychiatric in-patients who were complaining of the constant presence of anxiety symptoms. Objectively they appeared anxious and tense throughout the day. Other features such as obsessional

and depressive symptoms were sometimes present, but it was of their anxiety symptoms that they complained the most. Eighteen in-patients so selected were tested consecutively, but five had to be rejected as unsuitable owing to difficulty in falling asleep. The group thus finally consisted of thirteen patients, of whom ten were female and three male, the average age being 35·7 years.

(b) *Non-anxiety group*—The subjects in this group were all psychiatric in-patients who, whilst in hospital, were both subjectively and objectively free from anxiety. The majority were hysterical, mild depressive, or phobic states, who appeared quite relaxed during the day, though some became more disturbed when they had to leave hospital or face outside problems. One patient was a bland schizophrenic and two had been admitted for the treatment of alcoholism. Twelve patients so selected were tested consecutively, but two had to be rejected as unsuitable owing to difficulty in falling asleep. The group thus finally consisted of ten patients of whom eight were female and two male, the average age being 31·7 years.

(c) *Control group*—The subjects in this group were all medical colleagues (except for one—an occupational therapist) all known to the author to be relaxed individuals. Twelve such subjects were tested consecutively, but two had to be rejected owing to difficulty in falling asleep. The group thus finally consisted of ten subjects of whom three were females and seven male, the average age being 31·5 years.

(The preponderance of female subjects in the two experimental groups was entirely due to their greater availability to the writer, owing to the nature of his work. The preponderance of male subjects in the control group was merely a reflection of the sex ratio of the medical personnel of the hospital. No subject was included if a history of "cold fingers" or sensitivity to cold was elicited.)

EXPERIMENTAL PROCEDURE

The majority of subjects were tested on three or more separate occasions, either on consecutive days or within a day or so of each other. The first two tests were carried out in the waking state, and Seconal was administered during the final test.

Testing was carried out in a room maintained at a temperature of 22°C and under quiet conditions. The testing room was planned to be as relaxing and as free from instrumentation as possible. It was in fact a modified ward side-room comfortably curtained and carpeted. The only apparatus present was the amplifier of the plethysmograph, and this also served as a relay box for the various leads from the patient. All other instrumentation and recording apparatus were housed in an adjacent room and the author was able to communicate, if necessary, with the subject through a small hatch in the wall. In addition, it was possible to observe the subject through a "one-way" screen disguised in the wall and, by means of a sensitive microphone in the testing room, to listen to movement and breath sounds.

The subjects presented themselves at 10 a.m. on the morning of testing, having previously been instructed to take a normal breakfast, to abstain from smoking, and not to engage in any physical activity prior to testing. Some of the psychiatric patients were needing sedatives at night to aid sleep, and this was not discontinued on the night prior to testing. No sedatives were, however, administered to patients on the morning prior to testing.

After the volume of the finger-tip had been estimated, the E.E.G. electrodes were applied and the subject then lay on the bed. The respiration recorder was tied round the chest, and the skin-resistance electrodes applied. The plethysmographic cup was

then fixed in position on the finger, the air-tight seal was tested, and the amplification was adjusted. This procedure took, in all, some thirty minutes, and gave the subject time to acclimatize to the temperature conditions of the experiment.

The subject was then lightly covered, and was left alone for 20 min, during which time continuous recordings were taken. At the end of 10 min on the final testing occasion, Seconal was administered to the subject. This was given out of the capsules, dissolved in orange juice, and usually in a dosage of 3 gr. The subject was then told to relax and to try to sleep. Curtains were drawn and all noise prevented as far as possible.

In the earlier stages of the investigations, before the E.E.G. amplifier was available, it was necessary to assess the onset of sleep by listening to the breath sounds and by occasionally entering the testing room, observing the subject, and sometimes questioning him. With the availability of an E.E.G. recording, the determination of the onset of sleep presented no problem.

In the majority of subjects of all groups, sleep occurred within a half-hour of the Seconal being taken, and was allowed to continue for 45–60 min. It was not found necessary to prolong the sleep beyond this period, as vasodilatation, when it occurred, reached its maximum in the early stages of sleep. The subjects were woken with a cup of tea and usually given a 5-mg tablet of Dexedrine to counteract any drowsiness.

RESULTS

From the records of each resting test the following measures were obtained:—

1. Initial pulse-volume amplitude.
2. Maximum pulse-volume amplitude during test.
3. Initial pulse-rate.
4. Minimum pulse-rate during test.
5. Initial level of electrical skin resistance.
6. Maximum level of electrical skin resistance during test.

From the records of each sleep test the following measures were obtained:—

1. Initial pulse-volume amplitude.
2. Maximum pulse-volume amplitude during sleep.
3. Initial pulse-rate.
4. Minimum pulse-rate during sleep.
5. Initial level of electrical skin resistance.
6. Maximum level of electrical skin resistance during sleep.

The pulse-volume amplitude was obtained by direct measurement of the pulse deflection, sensitivity of the pen having been previously calibrated to give a 1-mm deflection for 1 mm^3 volume displacement. If much variation in amplitude was present, the average height of ten beats was taken. The volume of the subject's finger-tip having previously been measured, the figures so obtained from the direct recordings were then corrected to a standard 5-cm^3 finger-tip to make the readings comparable.

The pulse-rate was obtained from the plethysmographic record, measurements being taken over a thirty-second interval.

The skin-resistance level was obtained from the direct recording, and presented little problem owing to the changes in level being very slow in nature.

PULSE-VOLUME CHANGES

	Mean initial pulse volume	Mean pulse-volume increase
Resting tests		
Controls	9·4 mm³	1·0 mm³
Non-anxiety patients	5·8 mm³	1·6 mm³
Anxiety patients	3·4 mm³	1·0 mm³
Sleep tests		
Controls	10·1 mm³	0·55 mm³
Non-anxiety patients	6·3 mm³	2·3 mm³
Anxiety patients	4·9 mm³	12·3 mm³

The differences between the three groups in the pulse-volume changes during the resting tests are not statistically significant. However, the changes occurring during the sleep tests are highly significant. Analysis of variance reveals the significance to be beyond the 0·1 per cent level. The anxiety patients have a pulse-volume increase which is far greater than both the control and non-anxiety patients. The non-anxiety patients, though having a much smaller increase, still differ significantly from the control group. (See Appendix B.)

It will be seen that, both in the resting and in the sleep tests, the mean initial pulse-volume is greatest in the control subjects, least in the anxiety patients, with the non-anxiety patients coming in between. These differences are statistically significant (see Appendix B). This is consistent with the findings of previous workers. Individual figures show much overlap between the groups (see Appendix A), as has also been found by previous workers. The changes in the pulse-volume occurring during sleep, however, reveal no overlap at all, the anxiety patients separating themselves completely from the other two groups by the magnitude of their vasodilatation.

Range of Pulse-volume Increase During Sleep

Controls	0–2·5 mm³
Non-anxiety patients	0–5·0 mm³
Anxiety patients	6–23·0 mm³

Figs. 1, 2, and 3 below illustrate these differences and also demonstrate that they are not accounted for by differences between the size of the finger-tips of the subjects.

The significance of the pulse-volume changes will be further discussed later.

PULSE-RATE CHANGES

	Mean initial pulse-rate	Mean pulse-rate decrease
Resting tests		
Controls	68·3	4·1
Non-anxiety patients	70·8	2·4
Anxiety patients	69·6	3·3
Sleep tests		
Controls	72·2	6·3
Non-anxiety patients	69·4	1·9
Anxiety patients	70·7	9·2

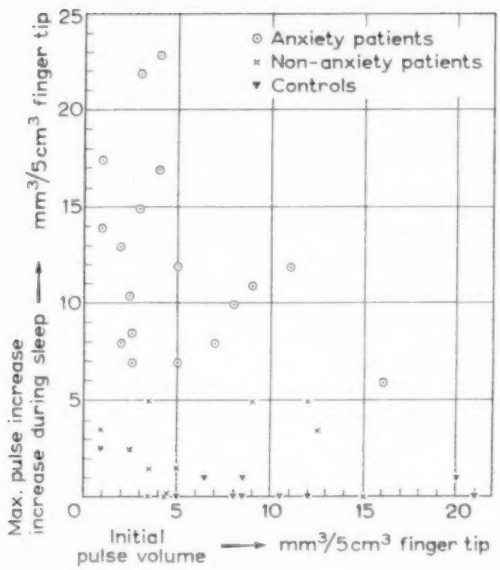

FIG. 1.—The relation of initial pulse-volume to the maximum pulse-volume increase during sleep.

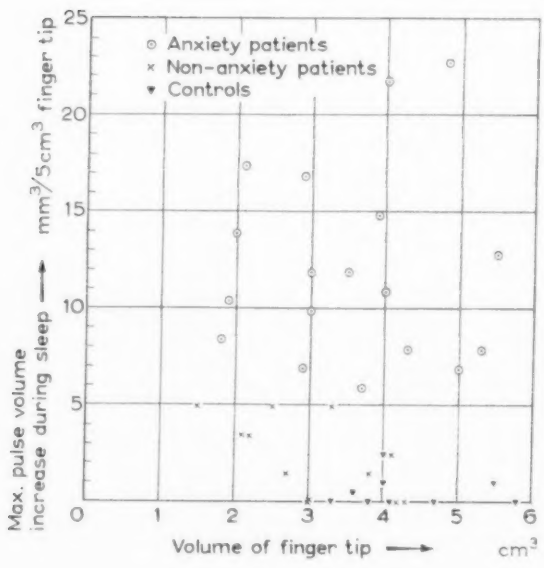

FIG. 2.—The relation of finger-volume to the maximum pulse-volume increase during sleep.

The differences between the three groups in the pulse-rate changes during the resting tests are not statistically significant. The changes occurring during the sleep tests are highly significant. Analysis of variance reveals the significance to be beyond the 0·1 per cent level. (See Appendix B.)

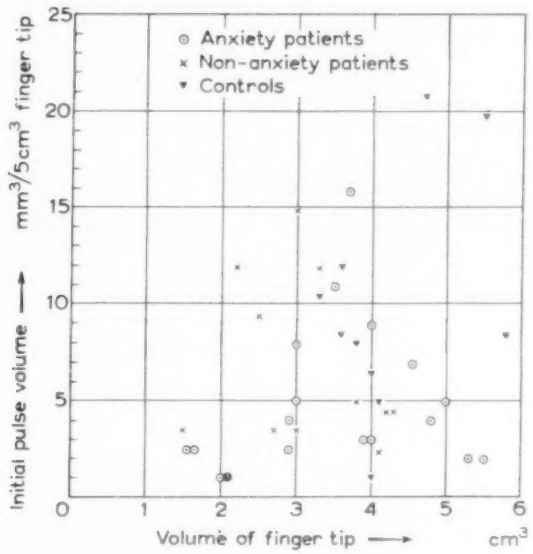

FIG. 3.—The relation of finger-volume to initial pulse-volume.

The anxiety patients have a pulse-rate decrease during sleep which is greater than both the control and the non-anxiety patients (significant at the 5 per cent and 0·1 per cent level respectively). The differences between the control and non-anxiety patients are also statistically significant. (See Appendix B.)

The average initial pulse-rate both in the resting and sleep tests show no significant differences, and the individual figures show much overlap. As distinct from the pulse-volume changes during sleep, the tendency to pulse-rate decrease during sleep reveals considerable overlap, and in this case the anxiety patients do not separate off from the other two groups (see Appendix A). Fig. 4 reveals that, although tending to a greater decrease during sleep, the figures for the anxiety patients show a very large scatter, the figures for the control subjects showing the least scatter. The figures for the non-anxiety patients also show a considerable scatter. The tendency of this latter group to decrease in the pulse-rate least during sleep is partly accounted for by two of the subjects showing no change and two of the subjects showing an actual increase in pulse-rate during sleep.

The significance of the pulse-rate changes will be further discussed later.

Changes in the Respiration Rate

During the early stage of the investigation there were some technical difficulties with the respiratory recording apparatus, but these were later overcome. This resulted in the respiratory tracings not being taken throughout the whole of the test period in some of the subjects. The figures for the respiration-rate changes are, therefore,

unfortunately incomplete and not fully comparable. Nevertheless, complete tracings were available in a large number of the subjects in each group, and these revealed no constant trend. During sleep the respiration-rate increased by a few cycles per minute in some subjects, whereas in other subjects a decrease was manifested. Increase and

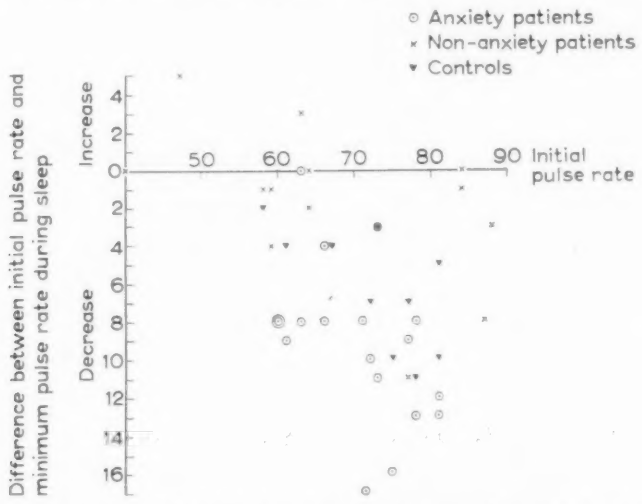

FIG. 4. The relation of initial pulse-rate to the minimum pulse-rate during sleep.

decrease in rate during sleep was recorded in subjects of both sexes in all groups, and bore no relationship to the pulse-volume changes.

Changes in Electrical Skin Resistance

A study of the changes in level of electrical skin resistance during both the resting and sleep tests revealed no constant trend in any of the groups, and the results are, therefore, not presented here in any detail. In all groups there was considerable variability, some subjects manifesting a rise in the skin-resistance level during testing and others a decrease. In the same subject, on different test occasions, changes could occur in opposite directions. The lack of a constant rise in the skin resistance during sleep may, perhaps, have been related to the administration of Seconal. The few subjects in each group in whom spontaneous sleep was achieved under test conditions all demonstrated a rise of comparable degree.

DISCUSSION

Peripheral Pulse-volume Changes

In agreement with previous workers, it has been demonstrated that, under controlled experimental conditions, the mean finger plethysmographic pulse-volume is significantly larger in a group of control subjects than in two groups of psychiatric patients. In the latter two groups, the mean pulse-volume is significantly larger in the group composed of manifestly anxious patients.

It has been further demonstrated that, during Seconal-induced sleep, the increase in the pulse-volume in both patient groups is significantly greater compared with the control group in which little change occurs. The increase is extremely marked in the group composed of manifestly anxious patients, and in this group the increase in

every case is larger than that manifested by any subject in either the control or the "non-anxiety" patient group.

There are a number of factors which might be considered to have had a possible influence on the experimental findings, and their effect on the validity of the latter will now be considered further.

Particular attention was paid to ensuring that the test conditions were as relaxing and as free as possible from emotionally disturbing factors. Nevertheless, it might be claimed that the results were largely the reflection of the anxiety induced by the test situation in a group of subjects who were easily prone to such reactions. There are a number of reasons why this is unlikely to be so. Most of the subjects in both patient groups had during their stay in hospital been exposed to a number of different testing situations. Prior to the sleep test in the present study, two or more resting tests had been carried out to ensure familiarity with the test situation. The subjects in both patient groups were, in fact, "test sophisticated." None of them expressed concern or appeared concerned by the test procedure, and a number expressed the view that it was quite a restful occasion. The taking of Seconal to induce sleep caused no concern, for the majority of the patients had, at some time, had experience of taking soporifics. In fact, as was to be expected with psychiatric patients, given adequate explanation and reassurance, they did not experience the environment as disturbing, their anxiety originating from within and derived from sources less real and comprehensible. If it were, in fact, true that the results could be attributed largely to the anxiety-provoking effect of the test procedure on the psychiatric patients, then it could be anticipated that the two patient groups would react similarly and distinctly from the control group. In fact, this was not so. The group composed of psychiatric patients who were not suffering from anxiety symptoms had a mean pulse-volume increase during sleep of only 2·3 mm^3 compared with the anxiety group, in which the increase was 12·3 mm^3. More significant is the fact that, whereas the mean pulse-volume increase during sleep of the "non-anxiety" group is greater than that of the mean increase of the control group, considerable overlap exists between the individual figures within these latter two groups, the range varying from 0 to 5 mm^3 (see Fig. 1). In the anxiety group the smallest pulse-volume increase recorded during sleep was 6 mm^3, and the majority of figures in this group was very much greater than this. The results for the "anxiety" group are thus very distinct from those of the "non-anxiety" group, the latter reacting more like the control group. The influence of the test procedure itself can, therefore, probably be largely discounted.

It might be considered that the greater increase in pulse-volume during sleep of the anxiety group is largely a reflection of the smaller initial pulse-volume compared with the other two groups. However, it is only the *mean* initial pulse-volume which is smaller, the actual individual figures in all groups showing considerable overlap. As will be seen from Fig. 1, small initial pulse-volumes in the "non-anxiety" and control groups are associated with small or no increase, whereas in the anxiety group there are some initial pulse-volumes of quite moderate size which are associated with a large pulse-volume increase. Furthermore, there is an over-swing effect in the anxiety group, for the increase is so large that the mean maximum pulse-volume amplitude during sleep is much greater than that in the other two groups. Clearly the size of the initial pulse-volume cannot be the determining factor in the large increase manifested by the anxiety group during sleep.

The mean size of the finger volumes in the control group is larger than that of the other two groups. There is, however, no significant difference in size between the "non-anxiety" and "anxiety" groups. Again, the individual figures reveal considerable overlap in all groups. That the size of the finger-tip is not a significant factor in determining the results is shown in Figs. 2 and 3. No relationship emerges between the size of the finger-tip and either the size of the initial pulse-volume or the pulse-volume increase during sleep.

To some extent the smaller finger-tips in the two patient groups are a reflection of the larger number of female subjects in these groups. However, the female subjects in the control group manifested little or no pulse-volume increase during sleep, and the male subjects in the anxiety group manifested a marked increase under the same conditions. The sex of the subject cannot, therefore, be considered to be an important determining factor.

It seems unlikely that the administration of Seconal, as such, had any influence in determining the difference between the groups. Mention has already been made of the ease with which the Seconal was taken by the patients. If anything, the greater experience by the patients of this drug should have resulted in a smaller reaction to it than in the control group. The fact that a few of the patients had needed a routine sedative on the night prior to the test could only have influenced the results against the direction of the findings. Under these conditions the tendency would be for these patients to present in a more relaxed state, perhaps still slightly under the influence of barbiturates. That it was sleep as such, and not the Seconal itself causing the vasodilatation during sleep in the anxiety patients, was clearly shown by the occasions on which the patient failed to sleep. On the latter occasions, despite the administration of Seconal little or no increase in pulse-volume would occur in the anxiety subjects. On a later occasion, the same dose of seconal might cause sleep in the same subject, and on this occasion an increase in the pulse-volume would occur with sleep. Nor did the quantity of Seconal administered appear to have any relation to the pulse-volume increases The majority of the subjects received a dosage of 3 gr, but some needed 4½ gr and others only 1½ gr. Some of the control and "non-anxiety" patients having the larger dosage showed no pulse-volume change during sleep, whilst a marked change occurred in some anxiety patients on the smaller dosage.

The duration of sleep appeared to have little influence on the results, for vasodilatation, if it did appear, reached its maximum in the early stages of sleep, tending to decline a little later. Nor did the depth of sleep, either judged clinically or by the E.E.G. record, appear to be at all significant. Many of the normal control subjects slept quite deeply, with no accompanying pulse-volume changes, whereas some of the anxiety subjects showing marked pulse-volume changes only slept lightly. Spontaneous natural sleep without the administration of Seconal was achieved in two control subjects and two "non-anxiety" patients under test conditions. In all these subjects there was little or no increase in pulse-volume during sleep. Spontaneous natural sleep occurred in one anxiety patient, and on this occasion there was a marked increase in pulse-volume during sleep (see Appendix A). There seems, therefore, little doubt that the important agent was not the seconal itself, but the sleep which it caused.

Some subjects tend to be cold-sensitive, and even under warm conditions manifest persistently cold fingers. Such subjects were excluded from all the groups. It does not

seem likely, therefore, that the pulse-volume increases found during sleep were due to the release of cold-sensitive vasoconstriction.

Other factors such as the tendency to slight temperature increase and sweat accumulation within the plethysmographic cup only had an effect on the finger volume base line, and probably varied little in their influence from one group to another.

With a few of the subjects it was possible to repeat the sleep test. On these occasions the results were found to be consistent, and pulse volume increases, if they occurred, were of comparable magnitude (see Appendix A).

Pulse-rate Changes

Although the differences between the three groups in the degree of pulse-rate reduction during sleep was found to be significant, certain discrepancies exist in the findings. The anxiety group as a whole decreases most, though the initial level from which it decreases is not significantly different from that of the other two groups. The control group, although decreasing less than the anxiety group, decreases far more than the non-anxiety group. In the latter group there is considerable scatter, two patients showing no change and two patients an actual increase in rate during sleep. In all groups there is considerable overlap in the individual figures, the control group, however, showing the least scatter.

BOAS and GOLDSCHMIDT (1932) have shown that the pulse rate during sleep is variable and far from consistent. Sleep tends to reduce the heart-rate, night sleep more than day sleep. The minimum rates may, however, be reached at varying times from the onset, sometimes not for many hours, and fluctuations may result in the rate being, at times, higher than in the waking state. Falling asleep and waking are associated with no consistent pattern. It would appear that, compared with the pulse-volume changes, the pulse-rate changes during sleep are so variable that their comparison from one case to another is rendered difficult, suitable criteria for measurement being lacking.

Perhaps the examination of the pulse-rate variability as distinct from the minimum rate over a long period of sleep, would yield interesting results. The design of the present study, however, did not admit of this.

Significance of Experimental Findings

The original hypothesis has been confirmed, the anxiety group being distinguishable from the other two groups on the basis of the pulse-volume increase occurring during sleep. It would seem profitable to examine to what extent the release of this emotional vasoconstrictor factor in the pulse-volume could be utilized in the study of anxiety. For example, to what extent is the degree of anxiety present related to the amount of pulse volume change occurring during sleep?

The patients in the anxiety group were all selected on the basis of subjective complaints, appearance, and behaviour, all of which left no doubt that the term "anxiety," as generally used, appropriately described an aspect of their emotional state. However, whilst it is not difficult to reach common agreement as to the applicability of the term "anxiety" to a group of subjects suffering from marked and overt signs and symptoms, it is far from easy to achieve a satisfactory method of rating the degree of anxiety present. The fact is, of course, that anxiety is a rather vague term often loosely used in a generic manner to apply to a variety of subjective complaints

and objective signs. These latter tend to occur under conditions in which the individual feels threatened by danger coming from either within or without, the nature and origin of which he may not always be fully aware. Anxiety is not an entity, but is a term which is applied to a state which can be qualified but not effectively quantified. For this reason no attempt has been made in the present study to rate and correlate the degree of anxiety present, as it was considered that this would not be a valid undertaking.

More valid than the attempted comparison of the state of anxiety between individuals would be the study of variations occurring within the same individual. An anxious subject having a pulse-volume increase during sleep should, on recovery from his disturbed emotional state, manifest little or no such change. This in fact was the case in two of the anxiety subjects on whom it was possible to repeat testing after their recovery. However, further investigation of this aspect will require somewhat different and more detailed experimental planning. A larger group of anxiety patients will be required in order to ensure an adequate number of subjects recovering within a reasonable period. Repeat testing of the recovered subjects will need to be accompanied by retesting at comparable intervals of non-recovered subjects as well as of control subjects.

Another profitable line of enquiry might be the study of the relationship of the pulse-volume increase during sleep to other objective physiological measures which are claimed to be highly associated with a state of anxiety. For example, it has been claimed by SHAGASS (1954) that emotional "tension" and sedation tolerance are highly correlated. Sodium amytal was administered intravenously at a constant rate whilst the E.E.G. was recorded. The E.E.G. sedation-threshold point was taken as the point at which there was a relatively sudden increase in voltage and amount of frontal fast activity. The more "tense" was the subject, the more sodium amytal was required to reach this point. Unfortunately, it was not possible to study this possible correlation in the present investigation, as the paper drive was not geared to give a faster speed than 16 mm per second, and this is too slow a speed to distinguish adequately frontal fast activity in the E.E.G.

Presumably, vasoconstriction of the skin vessels on an emotional basis is part of a bodily alerting reaction to stress and which probably serves the function of diverting blood to areas which are becoming mobilized for offensive or defensive action. The mechanism of the sustained vasoconstriction of the anxiety subjects is as yet not fully clear. Excess circulating adrenalin would not appear to be an important factor, for under these circumstances one would anticipate a raised pulse-rate. In fact, the resting pulse-rates of the anxiety groups did not differ significantly from those of the other two groups. Nor would an excess of noradrenalin (VON EULER, 1946) appear to be a likely cause, for under these circumstances an increase in the blood pressure could be anticipated. The resting blood pressures of the anxiety group were only very slightly in excess of the other two groups. Increased sympathetic activity along the vasomotor pathways would appear, at the moment, to be the most likely explanation.

SUMMARY

The quantitative study of the relationship of emotional disturbance to peripheral circulatory changes is rendered difficult by factors many of which are common to all attempts to correlate mental states with bodily change. These include difficulty in

characterizing and evaluating subjective emotion and difficulty in the experimental production and reproduction of comparable emotional states. The complexity of circulatory physiology is such that attempts must be made to hold many of the important factors constant, and this tends to limit the scope of the investigation into emotional factors. Limitation is also imposed by the unreliability of many techniques and the unsuitability of others for use with emotionally disturbed subjects.

A previous examination of the techniques available for the study of peripheral vasomotor activity revealed that, for use with emotionally disturbed subjects, finger plethysmography offered the most satisfactory compromise between simplicity of application and reliability of method. Earlier studies have shown some relationship between the size of the finger plethysmographic pulse-volume and the emotional state of the subject. It was concluded that further investigation of the influence of emotional disturbance on the size of the finger plethysmographic pulse-volume could be undertaken in a manner likely to yield useful quantitative results.

It was considered that the release of emotional vasoconstriction under conditions of induced mental relaxation might reveal differences between emotionally disturbed and relaxed subjects. The following hypothesis was subjected to experimental investigation: Under suitable testing conditions, sleep induced by Seconal in the morning should result in an increase in the finger plethysmographic pulse-volume in manifestly anxious subjects, but little or no change in subjects who are relaxed.

Three groups of subjects were used, two of which were composed of psychiatric patients. One group contained patients who complained of anxiety symptoms and were manifestly anxious. Another group was composed of psychiatric patients not subject to anxiety symptoms. The third group contained control subjects.

The experimental findings revealed that the three groups differed significantly both in the size of the pulse-volume during the resting state and in the increase in pulse-volume occurring during induced sleep. The marked pulse-volume increase during induced sleep occurring in the anxiety group completely distinguished all these subjects from those of the other two groups. The original hypothesis was thus confirmed.

The significance of these findings is discussed.

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APPENDIX A: INDIVIDUAL TEST FIGURES

TABLE 1.—RESTING TEST—CONTROLS

Subject	Pulse rate			Pulse volume (mm³/5 cm³ finger tip)			Finger vol. (in cm³)
	Initial rate	Min. rate	d.	Initial vol.	Max. vol.	d.	
C1 (m)	(1) 71	71	0	11·5	11·5	0	5·3
C2 (m)	(1) 70	65	−5·0	12·0	12·0	0	3·8
	(2) 64	64	0	6·0	6·0	0	3·4
	(3) 74	65	−9·0	7·0	7·5	+0·5	4·2
C3 (m)	(1) 65	59	−6·0	6·5	9·0	+2·5	5·0
	(2) 64	64	0	8·0	8·0	0	3·1
	(3) 78	68	−9·0	10·5	10·5	0	4·3
C4 (m)	(1) 59	58	−1·0	9·0	9·0	0	3·4
	(2) 64	59	−5·0	8·0	9·0	+1·0	3·9
C5 (m)	(1) 76	75	−1·0	18·0	19·0	+1·0	5·0
	(2) 68	62	−6·0	20·0	20·0	0	4·9
C6 (f)	(1) 79	68	−11·0	1·5	3·0	+1·5	3·3
	(2) 68	68	0	1·5	1·5	0	3·7
C7 (f)	(1) 71	67	−4·0	9·0	10·0	+1·0	3·5
	(2) 73	68	−5·0	8·5	10·0	+1·5	3·3
C8 (f)	(1) 58	53	−5·0	6·5	7·5	+1·0	4·1
	(2) 55	52	−3·0	4·5	7·0	+2·5	4·2
C9 (m)	(1) 74	73	−1·0	17·5	17·5	0	5·6
C10 (m)	(1) 62	56	−6·0	9·0	14·5	+5·5	4·5
	(2) 62	57	−5·0	12·5	15·0	+2·5	4·7
Mean	68·3	64·2	−4·1	9·4	10·4	+1·1	4·16

TABLE 2.—RESTING TEST—NON-ANXIETY PATIENTS

Subject	Pulse rate			Pulse volume (mm^3/5 cm^3 finger tip)			Finger vol. (in cm^3)
	Initial rate	Min. rate	d.	Initial vol.	Max. vol.	d.	
NA1 (f)	(1) 86	83	−3·0	10·0	14·5	+4·5	3·4
	(2) 81	80	−1·0	9·5	11·0	+1·5	3·2
NA2 (f)	(1) 71	67	−4·0	1·5	3·5	+2·0	1·4
	(2) 77	75	−2·0	3·0	4·5	+1·5	2·3
NA3 (f)	(1) 67	62	−5·0	16·0	20·5	+4·5	2·2
	(2) 64	64	0	13·0	13·0	0	3·4
NA4 (m)	(1) 68	67	−1·0	2·0	6·5	+4·5	3·8
	(2) 68	66	−2·0	6·0	6·0	0	4·8
NA5 (m)	(1) 66	63	−3·0	3·5	5·0	+1·5	4·1
	(2) 64	59	−5·0	3·5	7·0	+3·5	4·2
NA6 (f)	(1) 62	62	0	12·0	12·0	0	2·6
	(2) 69	67	−2·0	5·0	10·0	+5·0	2·0
NA7 (f)	(1) 84	81	−3·0	5·5	5·5	0	1·8
	(2) 85	76	−9·0	4·5	4·5	0	1·6
NA8 (f)	(1) 65	62	−3·0	1·0	2·5	+1·5	2·7
	(2) 61	60	−1·0	1·5	1·5	0	3·1
NA9 (f)	(1) 91	91	0	3·0	3·0	0	2·3
	(2) 69	69	0	4·5	4·5	0	3·2
NA10 (f)	(1) 47	45	−2·0	6·0	6·0	0	5·0
Mean	70·8	68·4	−2·4	5·8	7·4	+1·6	3·0

TABLE 3.—RESTING TEST—ANXIETY PATIENTS

Subject	Pulse rate			Pulse volume (mm³/5 cm³ finger tip)			Finger vol. (in cm³)
	Initial rate	Min. rate	d.	Initial vol.	Max. vol.	d.	
A1 (f)	(1) 65	64	−1·0	15·0	15·0	0	3·9
A2 (f)	(1) 82	76	−6·0	5·0	7·0	+2·0	3·1
	(2) 80	77	−3·0	4·0	12·0	+8·0	3·0
A3 (m)	(1) 66	64	−2·0	1·0	2·0	+1·0	4·8
	(2) 68	64	−4·0	2·0	2·0	0	4·6
A4 (f)	(1) 64	62	−2·0	3·5	3·5	0	2·1
	(2) 59	55	−4·0	1·5	1·5	0	2·8
A5 (m)	(1) 68	63	−5·0	4·0	6·0	+2·0	4·0
	(2) 70	67	−3·0	4·0	6·0	+2·0	4·5
A6 (f)	(1) 60	60	0	2·0	2·0	0	2·6
	(2) 64	61	−3·0	2·0	3·5	+1·5	2·2
A7 (f)	(1) 86	78	−8·0	2·0	2·0	0	4·3
	(2) 89	83	−6·0	4·0	4·0	0	4·2
	(3) 85	80	−5·0	3·0	3·0	0	4·1
	(4) 70	70	0	1·0	1·0	0	4·3
	(5) 75	70	−5·0	1·0	1·0	0	4·4
A8 (f)	(1) 69	62	−7·0	6·0	10·0	+4·0	3·4
	(2) 68	68	0	3·0	4·0	+1·0	3·5
A9 (m)	(1) 72	72	0	2·0	2·0	0	5·0
	(2) 68	64	−4·0	2·0	2·0	0	5·1
	(3) 69	64	−5·0	2·0	2·0	0	5·3
A10 (f)	(1) 65	63	−2·0	5·0	5·0	0	2·8
	(2) 72	63	−9·0	5·0	5·0	0	2·8
	(3) 63	62	−1·0	4·0	5·0	+1·0	3·2
A11 (f)	(1) 73	67	−6·0	2·0	8·5	+6·5	2·3
A12 (f)	(1) 62	62	0	5·0	6·0	+1·0	2·0
	(2) 66	63	−3·0	1·0	1·0	0	2·2
A13 (f)	(1) 61	61	0	3·0	3·0	0	1·7
	(2) 68	66	−2·0	4·5	4·5	0	2·3
Mean	69·6	66·3	−3·3	3·4	4·4	+1·0	3·46

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TABLE 4.—SLEEP TEST—CONTROLS

Subject	Pulse rate			Pulse volume (mm^4/5 cm^3 finger tip)			Finger vol. (in cm^3)
	Initial rate	Min. rate	d.	Initial vol.	Max. vol.	d.	
C1 (m)	(1) 81	76	−5·0	8·5	8·5	0	5·8
C2 (m)	(1) 77	70	−7·0	8·5	9·5	+1·0	3·6
C3 (m)	(1) 73	70	−3·0	8·0	8·0	0	3·8
C4 (m)	(1) 58	56	−2·0	12·0	12·0	0	3·6
C5 (m)	(1) 77	66	−11·0	21·0	21·0	0	4·7
	* 66	61	−5·0	16·0	16·0	0	5·1
C6 (f)	(1) 75	65	−10·0	1·0	3·5	+2·5	4·0
C7 (f)	(1) 72	65	−7·0	10·5	10·5	0	3·3
C8 (f)	(1) 67	63	−4·0	5·0	5·0	0	4·1
C9 (m)	(1) 81	71	−10·0	20·0	21·0	+1·0	5·5
	* 73	70	−3·0	17·5	18·0	+0·5	4·4
C10 (m)	(1) 61	57	−4·0	6·5	7·5	+1·0	4·0
Mean	72·2	65·9	−6·3	10·1	10·65	+0·55	4·24

* Spontaneous sleep.

TABLE 5.—SLEEP TEST—NON-ANXIETY PATIENTS

Subject	Pulse rate			Pulse volume (mm^3/5 cm^3 finger tip)			Finger vol. (in cm^3)
	Initial rate	Min. rate	d.	Initial vol.	Max. vol.	d.	
NA1 (f)	(1) 84	84	0	15·0	15·0	0	3·0
NA2 (f)	(1) 87	79	−8·0	1·0	4·5	+3·5	2·1
NA3 (f)	(1) 59	58	−1·0	12·0	17·0	+5·0	3·3
NA4 (m)	(1) 64	64	0	5·0	6·5	+1·5	3·8
NA5 (m)	(1) 59	55	−4·0	4·5	4·5	0	4·2
	* 62	60	−2·0	8·5	8·5	0	4·1
NA6 (f)	(1) 63	66	+3·0	12·5	16·0	+3·5	2·2
	(2) 64	62	−2·0	9·0	14·0	+5·0	2·5
NA7 (f)	(1) 76	65	−11·0	3·5	8·5	+5·0	1·5
NA8 (f)	(1) 58	57	−1·0	2·5	5·0	+2·5	4·1
NA9 (f)	(1) 88	85	−3·0	3·5	5·0	+1·5	2·7
	(2) 84	83	−1·0	3·5	3·5	0	3·0
NA10 (f)	(1) 47	52	+5·0	4·5	4·5	0	4·3
	* 50	49	−1·0	7·5	9·0	+1·5	4·5
Mean	69·4	67·5	−1·9	6·3	8·6	+2·3	3·06

* Spontaneous sleep.

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TABLE 6.—SLEEP TEST—ANXIETY PATIENTS

Subject	Pulse rate			Pulse volume (mm^3/5 cm^3 finger tip)			Finger vol. (in cm^3)
	Initial rate	Min. rate	d.	Initial vol.	Max. vol.	d.	
A1 (f)	(1) 73	62	−11·0	11·0	23·0	+12·0	3·5
	(2) 71	63	−8·0	16·0	22·0	+6·0	3·7
	* 63	61	−2·0	12·0	21·0	+9·0	3·9
A2 (f)	(1) 78	65	−13·0	8·0	18·0	+10·0	3·0
	(2) 81	69	−12·0	5·0	17·0	+12·0	3·0
A3 (m)	(1) 66	62	−4·0	5·0	12·0	+7·0	5·0
A4 (f)	(1) 63	55	−8·0	2·5	9·5	+7·0	2·9
A5 (m)	(1) 74	57	−17·0	4·0	27·0	+23·0	4·8
A6 (f)	(1) 63	63	0	2·5	13·0	+10·5	1·9
A7 (f)	(1) 81	68	−13·0	3·0	25·0	+22·0	4·0
A8 (f)	(1) 72	62	−10·0	3·0	18·0	+15·0	3·9
	(2) 75	59	−16·0	7·0	15·0	+8·0	4·3
	(3) 66	58	−8·0	9·0	20·0	+11·0	4·0
A9 (m)	(1) 77	68	−9·0	2·0	15·0	+13·0	5·5
	(2) 73	70	−3·0	2·0	10·0	+8·0	5·3
A10 (f)	(1) 60	52	−8·0	4·0	21·0	+17·0	2·9
A11 (f)	(1) 78	70	−8·0	1·0	18·5	+17·5	2·1
A12 (f)	(1) 60	52	−8·0	1·0	15·0	+14·0	2·0
A13 (f)	(1) 61	52	−9·0	2·5	11·0	+8·5	1·8
Mean	70·7	61·5	−9·2	4·9	17·2	+12·3	3·14

* Spontaneous sleep.

APPENDIX B. STATISTICAL TREATMENT

Initial Pulse-volume of Resting Tests

	Controls	Non-anxiety	Anxiety
Mean	9·39	5·8	3·4
S.D.	4·93	4·29	2·61
n.	20	19	29

Analysis of variance

	Degrees of freedom	Sum of square	Mean square
Between groups	2	520·65	260·33
Within groups	65	983·95	15·1
Total	67	1504·6	

$F = 17{\cdot}35$
$p = <0{\cdot}1$ per cent

t. test

	t.	df.	p.
Controls, non-anxiety	2·47	37	2·5 per cent
Non-anxiety, anxiety	2·19	46	5 per cent
Controls, anxiety	5·0	47	0·1 per cent

Pulse-volume Increases of Resting Tests

	Controls	Non-anxiety	Anxiety
Mean	1·02	1·58	1·03
S.D.	1·4	1·88	1·97
n.	20	19	29

Analysis of Variance

	Degrees of freedom	Sum of Square	Mean square
Between groups	2	4·47	2·24
Within groups	65	210·84	3·24
Total	67	215·31	

$F = 1{\cdot}45$
$p = >20$ per cent

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Pulse-volume Increases of Sleeping Tests

	Controls	Non-anxiety	Anxiety
Mean	0·55	2·29	12·3
S.D.	0·81	2·069	5
n.	10	12	18

Analysis of Variance

	Degree of freedom	Sum of square	Mean square
Between groups	2	1172·7	586·35
Within groups	37	479·29	12·95
Total	39	1651·99	

$F = 45{\cdot}3$
$p = <0{\cdot}1$ per cent

t. test

	t.	df.	p.
Controls, non-anxiety	2·68	20	1 per cent
Non-anxiety, anxiety	7·58	28	<0·1 per cent
Controls, anxiety	9·71	26	<0·1 per cent

Pulse-rate Decreases of Resting Tests

	Controls	Non-anxiety	Anxiety
Mean	4·1	2·42	3·31
S.D.	3·3	2·25	5·58
n.	20	19	29

Analysis of Variance

	Degree of freedom	Sum of square	Mean square
Between groups	2	27·27	13·63
Within groups	65	484·85	7·47
Total	67	512·12	

$F = 1{\cdot}85$
$p = >20$ per cent

Pulse-rate Decreases of Sleeping Tests

	Controls	Non-anxiety	Anxiety
Mean	6·3	1·9	9·17
S.D.	2·98	4·34	4·25
n.	10	12	18

Analysis of Variance

	Degrees of freedom	Sum of square	Mean square
Between groups	2	378·46	189·23
Within groups	37	593·52	14·04
Total	39	971·98	

$F = 13{\cdot}48$
$p = <0{\cdot}1$ per cent

t. test

	t.	df.	p.
Controls, non-anxiety	2·86	20	1 per cent
Non-anxiety, anxiety	4·5	28	<0·1 per cent
Controls, anxiety	2	26	5 per cent

APPENDIX C. CLINICAL DETAILS OF EXPERIMENTAL SUBJECTS

Anxiety Group

*A*1 (*f*)—*married*—(53)

An agitated depression with paranoid features with an onset eighteen months previously. Long background of marital difficulties. The patient appeared apprehensive and uncertain. She expressed many fears, particularly in relation to stories being spread around about her past life.

*A*2 (*f*)—*married*—(26)

A neurotic personality with six months' history of depersonalisation symptoms characterized by a feeling of loss of personality. Symptoms began following some gossip amongst her neighbours concerning her husband's infidelity. The patient appeared tense and restless. She complained of marked anxiety and easily became distressed at interview.

*A*3 (*m*)—(40)

Five years' history of chronic-anxiety symptoms associated with acute attacks and inability to leave home except in the company of his wife. Symptoms began following threat of wife leaving him and later financial and work difficulties. The patient appeared a thin, worried-looking, tense, and depressed individual with a fidgety uncertain manner. He complained of loss of confidence, restlessness, and inability to stop worrying.

*A*4 (*f*)—*married*—(35)

Five years' history of chronic-anxiety symptoms with acute attacks occurring intermittently in preceding two years. The patient appeared anxious, tense, and restless. She described recurring attacks of panic occurring on a background of a constant feeling of anxiety.

*A*5 (*m*)—(60)

An agitated depression with marked compulsive features increasing in severity during the preceding six years. Patient appeared tense, apprehensive, and depressed. He described a constant feeling of anxiety.

*A*6 (*f*)—*married*—(32)

Three year's history of anxiety and depressive symptoms largely reactive to home and marital difficulties. The patient appeared anxious, tense, and tearful. She expressed many fears, particularly in relation to her future.

*A*7 (*f*)—*single*—(39)

Seven months' history of mild depression, insomnia, nightmares, fears of going out alone, panic attacks, and irritability. Symptoms began following difficulties with the two elderly aunts who lived with her. The patient appeared anxious, tense, restless, and easily tearful. She described herself as constantly worrying, unable to relax or settle to any activity.

*A*8 (*f*)—*married*—(31)

A neurotic personality with one year's history of mixed anxiety and depressive symptoms with some hypochondriacal complaints. Onset following a dental extraction. The patient appeared tense and anxious, expressed many fears, and was very concerned about her health.

*A*9 (*m*)—(25)

Ten years' history of severe obsessional ruminations associated with marked anxiety and states of tension. The patient appeared anxious, very tense, and moderately depressed. He described the feeling of tension associated with his obsessional thoughts and a constant feeling that he might come into contact with the various objects which always increased his ruminations.

*A*10 (*f*)—*married*—(45)

Six years' history of intermittent attacks of agitated depression with marked hypochondriasis. The patient was agitated, apprehensive, and importunate in manner, expressing many fears concerning her body.

*A*11 (*f*)—*married*—(30)

Anxious, irritable, and easily upset for the preceding year since learning that she might have to move from the neighbourhood and be far away from her parents. The patient appeared mildly depressed, with a worried uncertain manner. She expressed many fears about the future and concern for her present state of health.

A12 (f)—married—(30)

Two years' history of recurrent depression and anxiety associated with ruminative ideas, probably partly reactive to domestic stresses. The patient appeared anxious, tense, and depressed. She complained of the anxiety associated with her ruminative ideas.

A13 (f)—single—(18)

Three years' history of increasing anxiety and depressive symptoms associated with headaches, nightmares, irritability, and loss of weight. Many social and sexual conflicts. The patient appeared anxious, tense, self-conscious, and uncertain in manner. She described herself as lacking in confidence and never free from a feeling of anxiety.

Non-Anxiety Group

NA1 *(f)—married*—(42)

A paranoid schizophrenic with eight years' history of delusional ideas of influence and more recent auditory hallucinations. The patient appeared bland in manner, with a flat emotional response. She was quite pleasant and co-operative, showing little concern about her delusional beliefs.

NA2 (f)—married—(26)

Eight months' history of ruminations of insanity and religious doubts following uncertainty over a possible pregnancy. Relaxed and at ease in hospital, but symptoms recurring whenever patient returned home on visits.

NA3 (f)—single—(19)

An immature hysterical personality admitted with hysterical symptoms largely reactive to difficulties with her father. At the time of testing she had lost her depressive symptoms, was cheerful in manner, and had few complaints apart from a fear of going out alone.

NA4 (m)—(41)

Admitted for treatment of sixteen years' chronic alcoholism. Cheerful in manner and complaining of no anxiety symptoms.

NA5 (m)—(32)

Admitted for treatment of ten years' chronic alcoholism. Mildly depressed in appearance, but co-operative and expressing himself as feeling quite relaxed and at ease.

NA6 (f)—single—(35)

Admitted with depressive symptoms reactive to breaking off an affair with a married man three months previously. At the time of testing all her symptoms had disappeared, apart from a complaint of easy fatiguability.

NA7 (f)—single—(35)

Eighteen months' history of anxiety symptoms related to concern over dermatitis of face. Quick resolution of dermatitis with sedation and supportive psychotherapy. At the time of testing, the patient was relaxed, at ease, and complaining of no anxiety symptoms.

NA8 (f)—married—(24)

Four months' history of anxiety and depressive symptoms following death of father. Treated by psychotherapy directed to ventilating her difficulties with her mother. At the time of testing, the patient was very much improved, with no anxiety symptoms and only occasional brief depressive moods.

NA9 (f)—married—(24)

Anxiety and depressive symptoms beginning following childbirth three months prior to admission. Treated by psychotherapy directed towards resolving conflicts over her dependence on her mother and her rejection of her own child. At the time of testing, the patient was almost recovered, with only some residual fears of going out alone.

NA10 (f)—married—(39)

Five months' history of vertigo and headache following a very mild accident. Considered to be largely a hysterical reaction related to claims for compensation together with difficulties over an unhappy love affair. At the time of testing she expressed many complaints, but in fact appeared quite relaxed and at ease. Her behaviour in the ward and at social functions belied her complaints.

APPENDIX D. SAMPLES OF RECORD TRACINGS

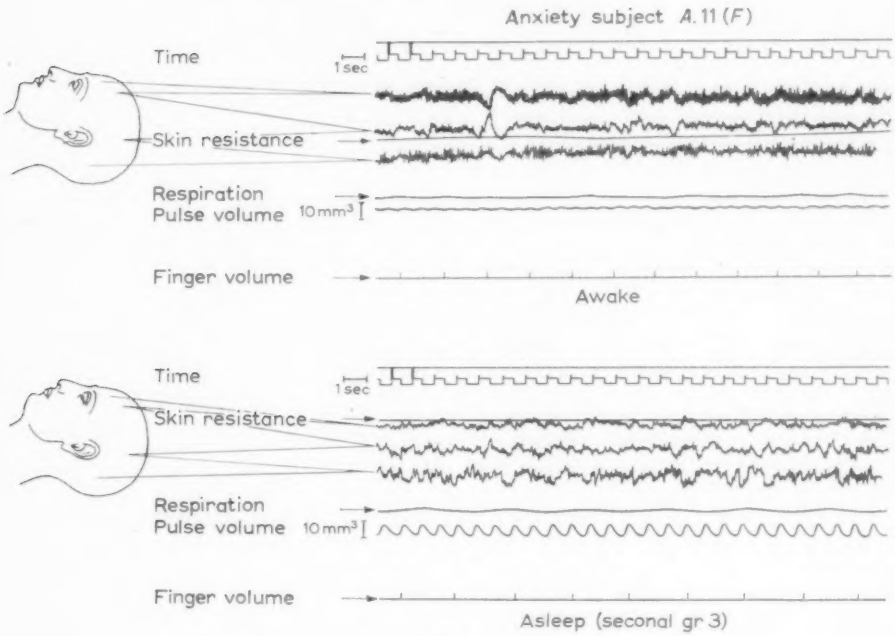

FIG. 5.

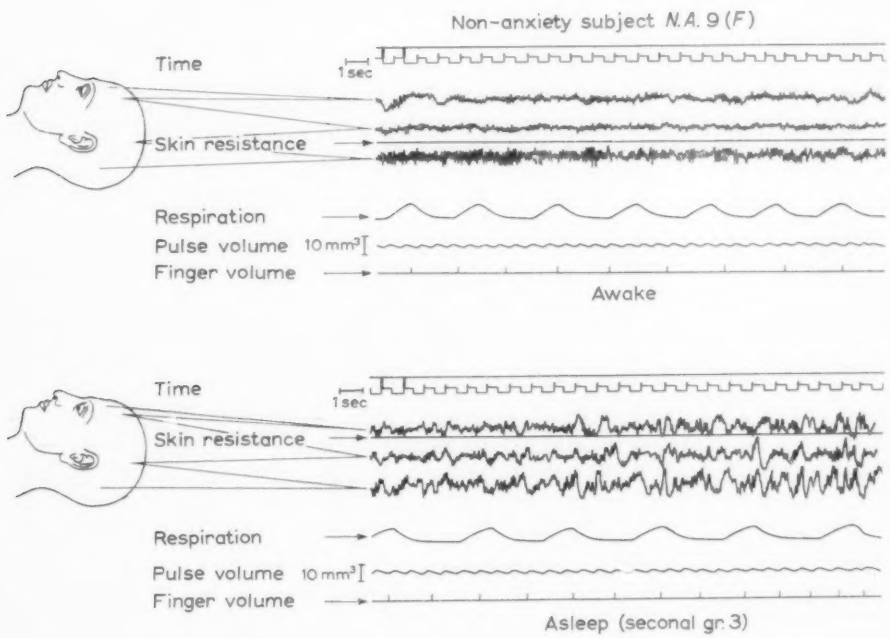

FIG. 6.

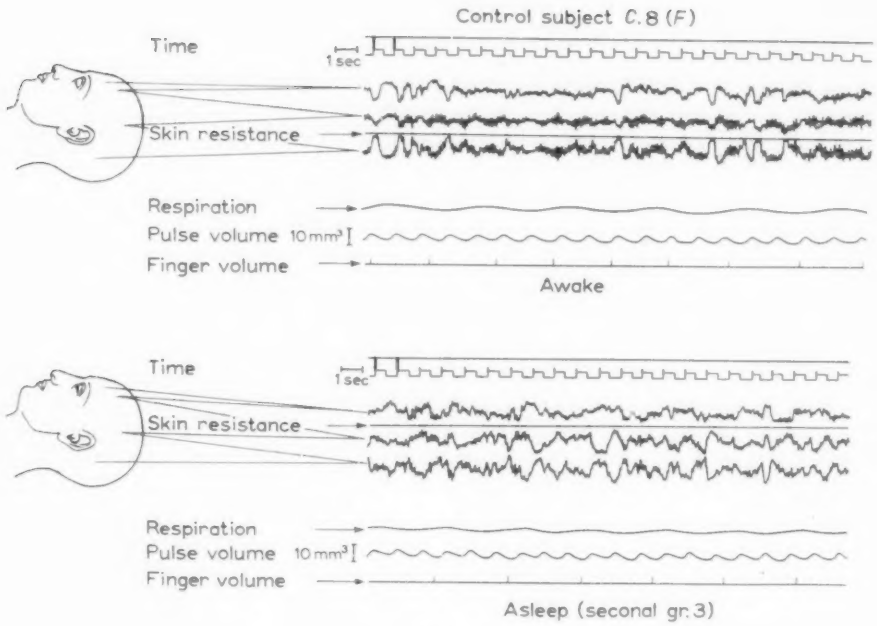
Control subject C. 8 (F)
Time
1 sec
Skin resistance
Respiration
Pulse volume 10 mm³
Finger volume
Awake
Time
1 sec
Skin resistance
Respiration
Pulse volume 10 mm³
Finger volume
Asleep (seconal gr. 3)

FIG. 7.

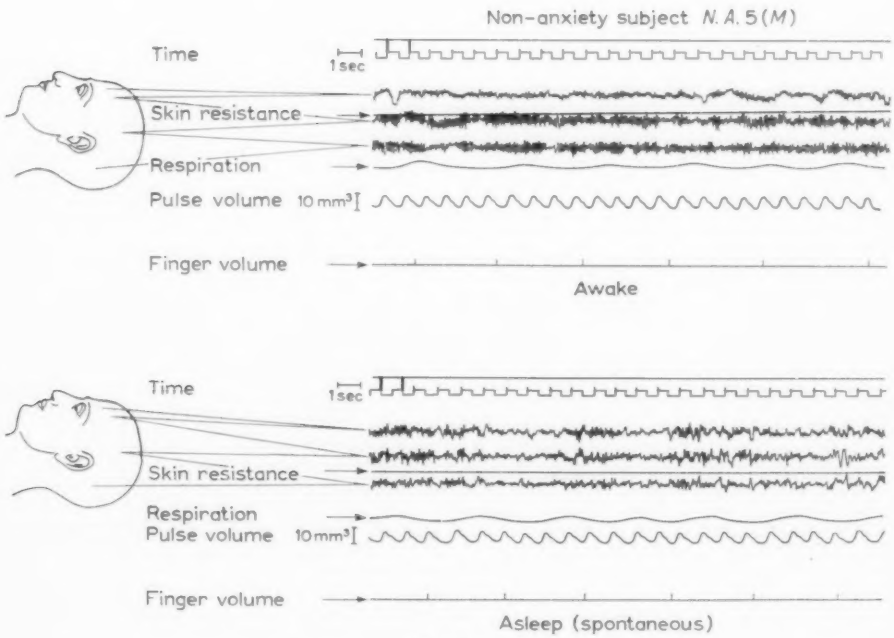
Non-anxiety subject N. A. 5 (M)
Time
1 sec
Skin resistance
Respiration
Pulse volume 10 mm³
Finger volume
Awake
Time
1 sec
Skin resistance
Respiration
Pulse volume 10 mm³
Finger volume
Asleep (spontaneous)

FIG. 8.

Journal of Psychosomatic Research, 1956, Vol. 1, pp. 49 to 57. Pergamon Press Ltd., London

THE SEDATION THRESHOLD AS AN OBJECTIVE INDEX OF MANIFEST ANXIETY IN PSYCHONEUROSIS*

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(*Received September* 1955)

ANXIETY is a concept of central importance in psychiatry, and adequate objective indicators of anxiety are greatly needed for clinical and research purposes. The sedation threshold method was developed to provide one such indicator (SHAGASS, 1954).

The rationale of this method stemmed from two sources. The first was the concept that some central cerebral function would probably be a closer physiological correlate of tension or anxiety than any peripheral function. Second, there was the common clinical observation that, the more anxious the patient, the greater the amount of sedative required to produce a given therapeutic effect. These considerations led to the idea of measuring anxiety by determining the amount of intravenous barbiturate required to depress cerebral excitability to a given level. To carry out such a "cerebral titration," a suitable indicator or end-point was required. This was provided by the discovery that sodium amytal consistently produces certain quantitative EEG changes, which are associated with onset of slurred speech (SHAGASS, 1954). The amount of drug taken to produce these changes, which varies from person to person, is called the sedation threshold.

The first clinical investigation of sedation threshold indicated that it was highly correlated with psychiatric assessments of degree of tension or manifest anxiety‡ in psychoneurotic patients (SHAGASS, 1954). The main purpose of the present study was to obtain further evidence bearing on the validity of the sedation threshold as a measure of manifest anxiety.

The study was designed to provide two criteria of validity. The first criterion involved a comparison of the sedation thresholds of psychoneurotics with those of non-patient controls. Since patients have more manifest anxiety, their thresholds should be higher. The second criterion was concerned with the extent to which the threshold distinguishes between neuroses which differ from one another in degree of manifest anxiety. Most clinicians would agree that manifest anxiety is greatest in anxiety states, least in hysteria, and of intermediate degree in the other neuroses. To meet the second criterion, it was considered that the sedation threshold should duplicate this clinical ranking of manifest anxiety. Furthermore, it should differentiate between the various types of neurosis in a statistically significant manner.

In addition to the main purpose of this study, two subsidiary aims were realized.

* Supported by Defence Research Board of Canada. Grant No. 9345-04, Project D50-93-45-04.

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‡ The qualifying term, "manifest," is used here to avoid confusion with such concepts as "unconscious anxiety" (FENICHEL, 1945). "Manifest anxiety" is intended to designate only anxiety which is judged present from direct evidence obtained by clinical psychiatric examination. "Tension" was used in a similar sense in the earlier report (SHAGASS, 1954), but subsequent experience suggested that "manifest anxiety" is probably more appropriate (SHAGASS, NAIMAN, and MIHALIK, 1956).

One was the determination of sedation threshold norms for a non-patient control population. This information, which was needed for the first criterion, had not previously been obtained. The other was a study of the stability of the threshold, which was determined by retesting a group of patients.

METHODS AND MATERIALS

Sedation threshold procedure. The method has been described in detail elsewhere (SHAGASS, 1954). Sodium amytal is injected intravenously at the rate of 0·5 mg/kg every 40 sec. Other injection rates were previously used; this is the latest and most extensively used rate. The injection solution is made up so that 1 cc contains 0·5 mg/kg body weight. At the beginning of every 40-sec interval,

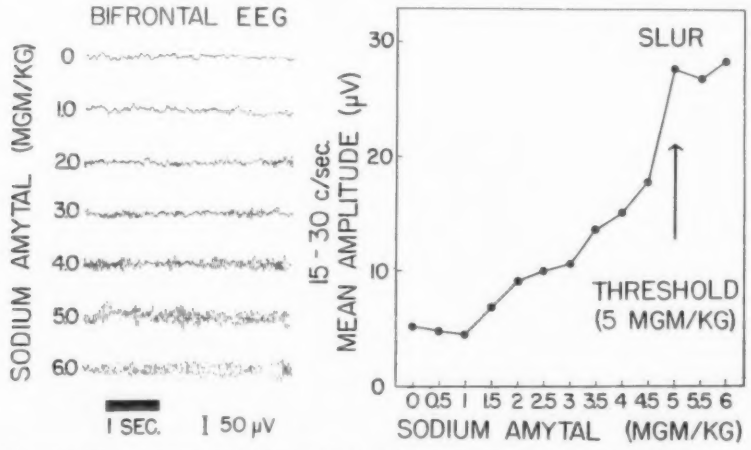

FIG. 1.—Effect of sodium amytal on bifrontal EEG. Note progressive increase of fast-frequency amplitude. Arrow points to inflexion point in the amplitude curve, which indicates sedation threshold.

1 cc is injected as rapidly as possible; 25 sec later the patient is asked to repeat sibilants, such as: "5-6-7, 77, Massachusetts." The injection is continued for two or more intervals after slurred speech is noted. The EEG is recorded continuously. The optimal effect of sodium amytal is usually recorded from transverse frontal electrodes. Fairly often, because it is impossible to obtain a muscle-free transverse frontal tracing, it is necessary to measure the tracing obtained from electrodes placed in the sagittal plane at the frontal and vertex positions.

Fig. 1 shows that sodium amytal produces a rather striking increase of fast-frequency (15 to 30 c/sec) activity. The amplitude of this fast activity may be taken as the response to the drug and a dosage-response curve plotted. A fairly typical curve is shown in Fig. 1. The typical curve has a sigmoid shape, and contains a point of inflexion, preceding which there is a sudden increase in the amplitude of the fast activity, and following which the curve tends to plateau. This inflexion point generally occurs within 40 sec (0·5 mg/kg) of the time when slurred speech is first noted, and the slur and inflexion point are used together as indicators of the threshold. The threshold is the amount of sodium amytal, in mg/kg, required to produce an inflexion point in the 15 to 30 c/sec amplitude curve, which occurs within 80 sec (1 mg/kg) of the time when slur is noted. The slur localizes the threshold roughly, the EEG inflexion point does it more precisely.

The patient must be reasonably co-operative. About one out of every ten tests performed has to be discarded for such reasons as: difficulty with venipuncture, excessive movement and muscle artifact in the tracing, absence of inflexion point in the measured curve, and too great a discrepancy between the slur and EEG inflexion points.

Subjects. There were 121 psychoneurotic patients and 45 volunteer control subjects. The patient group included all of the psychoneurotics, who could be clearly diagnosed and whose tests were technically valid, in the first 344 patients tested; 8 neurotic patients in the total series were omitted

because of difficulty in classification. There were 48 men and 73 women; ages ranged from 18 to 62, with a median of 34·9 years. Alcoholics and addicts were excluded. Rate of injection for 25 patients was 1 mg/kg/min, instead of 0·5 mg/kg/40 sec. Results were similar for both injection rates; hence they were grouped together. The control group contained 34 men and 11 women, and ranged in age from 17 to 45, with a median of 21·2 years. Control and patient groups differed in age and sex, but these differences did not influence results, since age and sex are not related to sedation threshold.

Diagnostic classification was based on all clinical information available from an interview carried out in the laboratory by one or both investigators and from the entire record of a hospitalization period averaging thirty-five days. It is recognized that hard and fast diagnostic criteria are difficult to apply. For present purposes every attempt was made to identify the predominant aspects of the illness and to classify these predominant findings by means of diagnostic criteria which were as objective as possible. Certain diagnostic categories, e.g., conversion hysteria and obsessive compulsive neurosis, could be defined more objectively than others. In addition to consideration of the symptom picture, an attempt was made to assess personality or character features, with particular emphasis upon evidence of hysterical or obsessional personality traits. In this connection, conventional concepts were followed: the hysterical prototype was taken as dramatic, immature, and egocentric; the obsessional prototype was taken as meticulous, perfectionistic, and rigid.

The diagnostic criteria employed may be outlined as follows:

Conversion hysteria (14 cases). This group was composed only of patients who presented with major somato-sensory conversion symptoms. These included: motor paralyses, amnesia, blindness, deafness, loss of consciousness, paresthesia, and globus.

Hysterical personality (12 cases). The patients classified as hysterical personality did not present with major conversion symptoms, the most common complaints being either anxiety or depression. However, during the examination and subsequent stay in hospital, each showed marked histrionic and manipulative behaviour, and gave clear evidence that presenting symptoms were of a communicative nature and that there was a major element of secondary gain in the illness.

Mixed neurosis (28 cases). Patients diagnosed as mixed neurosis usually presented with a variety of complaints indicating anxious, depressed, hysterical, and obsessive features, but without predominance of any one. In this group the personality picture also seemed to be mixed and could not often be classified as either predominantly hysterical or predominantly obsessional.

Anxiety hysteria (8 cases). Patients were classified as anxiety hysteria only where phobias were the main presenting complaints. Most of these patients seemed to have hysterical personality features, but phobic anxiety was much more prominent than in the patients classed as hysterical personality.

Obsessive compulsive neurosis (8 cases). This diagnosis was restricted to classical obsessive compulsives, showing either rituals or ruminations, or both.

Neurotic depression (22 cases). The main feature characterizing the neurotic depression group was the prominence of depression as a presenting complaint, either alone, or in conjunction with anxiety. Nearly half of the patients reported suicidal ruminations, and a small number had made suicidal attempts. The personality was obsessional in the majority of cases.

Anxiety state (29 cases). The presenting symptoms in the anxiety state group consisted mainly of anxiety and tension, with associated somatic complaints. Personalities were mainly obsessional. The problem of differentiating between the anxiety state and neurotic depression groups was a difficult one; it is likely that different examiners would shift some patients from one group into the other. Both groups were mainly obsessional. The major point of distinction was whether the presenting complaints emphasized depression or anxiety, but both were present in a considerable number of patients.

RESULTS

Patient-control difference. Percentage distributions of sedation thresholds in the patient and control groups are shown in Fig. 2. Mean threshold of the control subjects was 3·09 mg/kg, which was significantly lower than the mean of 4·15 for the neurotics ($P < 0·001$). These results meet the first criterion of validity, that of patient-control difference.

It will be noted that the distribution of thresholds for the control group followed a symmetrical normal curve pattern, and that the range was considerably narrower than that of the patient group. The narrower range of the controls would be expected,

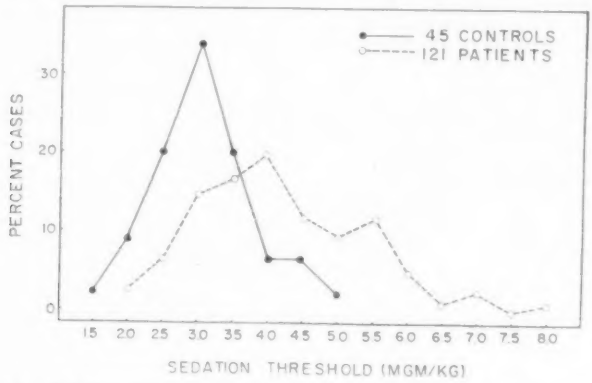

FIG. 2.—Sedation threshold distributions for psychoneurotic and control groups.

since they were a more homogenous group. The normal curve pattern suggests that the threshold is distributed in the same way as other basic biological variables.

Differences between patient groups. Fig. 3 shows the distribution of sedation

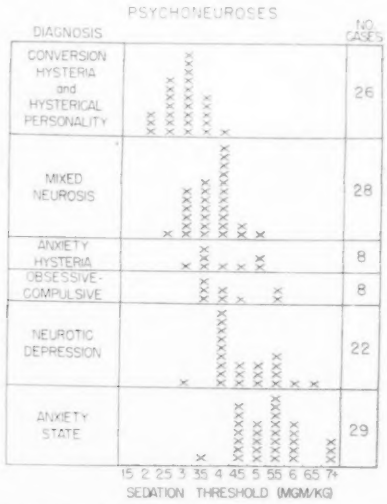

FIG. 3.—Sedation threshold distribution for various neurotic groups.

thresholds for each patient group. The conversion hysteria and hysterical personality groups were placed together, since there was no difference between them. Thresholds in the hysteric group were nearly all low, whereas those in the neurotic-depression and anxiety-state groups were nearly all high. In the two latter groups there were only two cases out of fifty-one with a threshold below 4·0 mg/kg; it is of interest that both were thought to be hysterical personalities. Thresholds in the mixed-neurosis, anxiety-hysteria, and obsessive-compulsive groups were intermediate between those of the hysterics and the neurotic depressions.

Mean thresholds for each group, in mg/kg, were as follows: hysteria, 2·88; mixed neurosis, 3·68; anxiety-hysteria, 4·00; obsessive-compulsive, 4·25; neurotic-depression, 4·64; anxiety-state, 5·38. Tests of statistical significance permit the following statements, based on differences significant at better than the 1 per cent level of confidence:

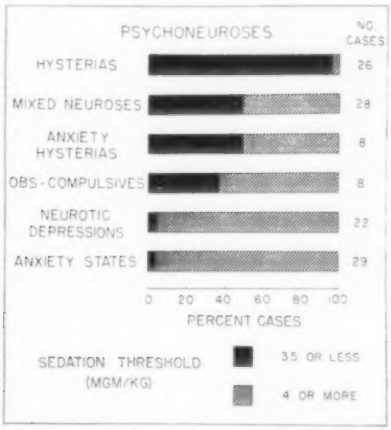

FIG. 4.—Differentiation between psychoneurotic groups by a division point between thresholds of 3·5 and 4·0 mg/kg.

Thresholds of the anxiety-state group were higher than those of any other group, including the neurotic depressions. The hysterics had lower thresholds than any other patient group. The neurotic depressions were higher than the mixed neuroses. The control group was lower than any other group, except the hysterics. These results show that the sedation threshold differentiates significantly between various neurotic groups, and ranks them in the order expected from clinical appraisal of manifest anxiety. They thus fulfil the second criterion of validity, stated in the introductory section of this paper.

Fig. 4 shows the differences between the various neurotic groups in terms of chances that the threshold will be 3·5 mg/kg or less, or 4·0 mg/kg or more, in a patient with a given diagnosis. This division point approximates the median for all patients so far tested, including psychotics. Nearly all of the hysterics were below, nearly all of the neurotic depressions and anxiety states were above, and the other groups were almost equally distributed above and below this median threshold. It is clear that one could differentiate neurotic depressions and anxiety states from hysterics with considerable accuracy by means of this test.

Test-retest reliability. Repeat tests were carried out on 20 patients. The correlation between thresholds obtained on initial and repeat tests is shown by the scatterplot in Fig. 5. Intervals between tests ranged from three to four hundred days; the median interval was thirty days. Re-admission to hospital of a few patients provided the opportunity to repeat the test after a long interval. The product-moment correlation coefficient for the data in Fig. 5 was 0·91. Mean thresholds for initial and repeat tests were 4·48 and 4·55 mg/kg, respectively. In 18 of the 20 cases, the difference between test and retest was 0·5 mg/kg or less. These results indicate that the threshold is very stable, and that changes greater than 0·5 mg/kg may probably be regarded as

significant of a rise or fall in anxiety. The two patients whose thresholds decreased by more than 0·5 mg/kg on retesting, actually did show considerable clinical improvement.

Effect of age and sex. In the patient group no statistically significant correlations were found between the sedation threshold and age. There were also no significant sex differences.

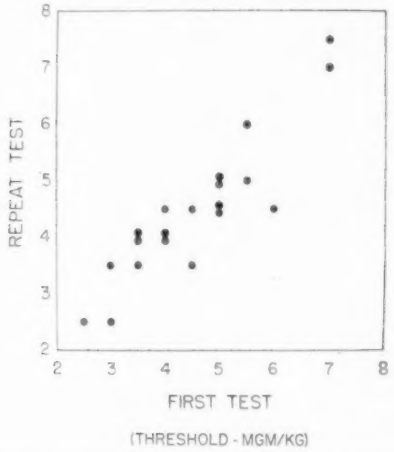

FIG. 5.—Correlation between initial and repeat sedation thresholds of twenty patients.

Effect of previous sedation. To determine the effect of previous sedative intake on the threshold, patients were divided into two groups: those receiving no sedatives, and those with a history of regular sedative consumption. Only cases for whom a reliable sedative history could be obtained were included. The mean sedation thresholds of these two groups were almost identical. Since addicts and alcoholics were excluded, this indicates that the threshold is not affected by previous sedation in amounts usually given psychiatric patients.

DISCUSSION

Present findings provided strong support for the conclusion that the sedation threshold measures manifest anxiety in psychoneurotics. Since the threshold has also been found to correlate with degree of anxiety in control subjects, (SHAGASS and NAIMAN, 1955) this conclusion appears to hold for non-psychotic individuals in general. Special factors appear to operate in psychotics (SHAGASS, NAIMAN, and MIHALIK, 1955; SHAGASS and NAIMAN, 1955). This study also provided evidence that the sedation threshold tends to be stable and that the test-retest reliability of the procedure is high.

Psychiatric use of the term "anxiety" probably covers a number of reactions which, although psychologically similar, may be quite different neurophysiologically. To produce correlations of the order observed here, the sedation threshold must measure one of the important neurophysiological mechanisms involved in anxiety. There are probably other mechanisms, whose measurement would require other indicators. Using an adequate number of indicators, a given patient's anxiety could be described in objective terms. With experience, such information should lead to more precise diagnosis and therapy. The potential clinical value of this approach may perhaps be illustrated by an analogy, in which fever is equated with anxiety and the sedation

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threshold is equated with the leukocyte count. The clinical significance of fever associated with a high white count is considerably different from that of fever associated with a low white count. Similarly, the significance of anxiety associated with a high sedation threshold probably differs a great deal from that of anxiety associated with a low threshold.

The sedation threshold procedure has been used as a clinical test at the Allan Memorial Institute since early 1954. In the opinion of clinicians using it, the results have been of considerable value in differential diagnostic assessment. A high threshold frequently points to a degree of anxiety previously unsuspected in that patient. A low threshold suggests that more emphasis should be placed on the communicative aspects of the complaint picture. Where there has been disagreement between the threshold and the initial assessment, continued observation has usually supported the threshold findings. For example, one patient, who on admission was considered extraordinarily anxious by several physicians, was found to have a low threshold. After a period of attendance at the day hospital, the patient reported to her physician that she was losing consciousness dozens of times each day, and suggested that she be admitted to the day and night ward. Since it was already suspected that she might be a hysteric, investigations were first carried out. When no objective evidence of epilepsy was found, the patient was informed that under no circumstances would she be admitted for full-time care. Her so-called seizures immediately stopped.

It would be undesirable to leave the impression that the technique is completely mechanical and simple. Unfortunately, although various means of simplifying the method are being tried, it is still time-consuming and considerable skill is required to obtain an optimal yield of valid tests. One important technical factor is the ability of the physician to control the patient so as to give minimum EEG artifact during the injection. Also, the rather laborious task of measuring the records must be done with obsessive attention to detail. Since most of the technical difficulty in the procedure seems to involve the EEG, and since slurred speech alone might serve as an end-point, one may question the necessity of taking the EEG. However, judgement of slur is subjective and seems to become more difficult as, with experience, one learns to distinguish several grades of slurring. While slur alone may be an adequate indicator for extremely high or low thresholds, EEG control is needed for most of the intermediate ones.

Present data revealed a strong association between sedation threshold and the relative predominance of hysterical or obsessional personality characteristics. Thresholds of hysterics were generally low, those of obsessionals were generally high. If one assumes some kind of personality continuum, with the hysteric at one extreme and the obsessional at the other, the sedation threshold probably gives a fairly accurate indication of the position of an individual on this continuum. This personality correlate of the sedation threshold should perhaps be emphasized as much as its correlation with manifest anxiety, since it provides a link with important experimental evidence obtained by other methods.

The notion of a continuum from hysterical to obsessional is not new and, in the past, has been the basis of a number of personality typologies. EYSENCK (1947) has approached this problem experimentally. Using a variety of tests and the statistical method of factor analysis, he was able to define three dimensions of personality. One of these, called the "introversion-extraversion" dimension, seems closely related to the

hysterical-obsessional continuum. The classical hysteric is the extreme extravert; the obsessional is the extreme introvert. In a recent study by one of EYSENCK's students, HILDEBRAND (1953), introversion-extraversion scores based on six objective psychological tests and a body index were determined for neurotic patients, who were divided into diagnostic categories similar to those used in this study. The order in which the various neuroses were arranged by the introversion-extraversion score was remarkably similar to the order in which they were arranged by the sedation threshold. This agreement between results, obtained by completely independent and different experimental approaches, suggests that these various methods measure some common central nervous function. Degree of anxiety and relative predominance of hysterical or obsessional personality traits appear to be behavioural manifestations of this function.

From the neurophysiological point of view, present results indicate that a knowledge of the locus and mode of action of barbiturates on the central nervous system would contribute greatly to an understanding of the neural mechanisms involved in anxiety. There is considerable evidence that the reticular systems of brain-stem and thalamus are especially sensitive to the effects of barbiturates (FRENCH *et al.*, 1953; SCHNEIDER *et al.*, 1952). It seems reasonable to assume that these systems are involved in an important way in the anxiety reaction, but detailed evidence is unavailable.

Another line of neurophysiological evidence concerns the excitability cycle of brain cells. GASTAUT and his co-workers (GASTAUT, 1951), in a study of cortical excitability cycle, demonstrated that barbiturates diminish the amplitude of cortical responsiveness to photic stimuli, and lengthen the time it takes to recover normal excitability. This direct evidence, that barbiturates reduce cortical excitability, supports the interpretation of the sedation threshold as a measure of cerebral excitability. It also indicates that anxiety, associated with a high threshold, reflects increased cerebral excitability. Additional evidence in favour of this conclusion was obtained in recent studies of anxiety by means of the EEG response to photic stimulation (SHAGASS, 1955).

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SUMMARY

1. The sedation threshold is an objective index of sedative tolerance, based on EEG and behavioural response to intravenous sodium amytal. The method was developed to provide an indicator of tension or anxiety. The main purpose of this study was to make further experimental tests of the validity of the sedation threshold as a measure of manifest anxiety in psychoneurotics. In addition, sedation threshold norms for non-patient controls were determined and data bearing on the test-retest reliability of this method were obtained.

2. The results met two criteria of validity. (a) Sedation thresholds of 121 psychoneurotic patients were significantly higher than those of 45 controls. (b) Within the patient group, there was a high degree of correlation between the threshold and degree of manifest anxiety, predicted on clinical grounds. Highest thresholds were found in anxiety states, followed by neurotic depressions, obsessive compulsives, anxiety hysterias, mixed neuroses, and hysterias, in that order. All intergroup differences, except those involving the small obsessive and anxiety-hysteric groups, were statistically significant.

3. The test-retest reliability in 20 patients was very high.

4. There was a definite tendency for high thresholds to be associated with obsessional and low thresholds with hysterical personality traits.

5. It was concluded that the sedation threshold is a valid and reliable measure of manifest anxiety. Practical application of the test in differential diagnosis was discussed.

6. The close agreement between present findings and those of EYSENCK, which are based mainly on psychometric tests, was noted. It was suggested that these various tests probably measure different aspects of the same basic central nervous function. The probable close relationship between this function and "cortical excitability cycle" was considered, and the conclusion drawn that manifest anxiety probably reflects an increased level of cerebral excitability.

Acknowledgements—The authors wish to acknowledge the technical assistance of SABINA MIGICOVSKY, JULAINE MARTIN, and ANN KRYCHMAN. Thanks are also due to Drs. R. A. CLEGHORN and R. B. MALMO for critical reading of the manuscript.

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REPRODUCIBLE PSYCHOGENIC ATTACKS OF ASTHMA*

A LABORATORY STUDY

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INTRODUCTION

THE histories obtained from patients with asthma often contain examples of asthmatic attacks following emotional events. Most of these observations, as recorded in the literature, are of an anecdotal character (DUNBAR, 1938). Clinical observations (MILLER, 1950, 1953; BASTIAANS, 1954; HUET, 1953), the investigation of patients by means of psychoanalysis (FRENCH, 1951), or the method of biographical anamnesis (BASTIAANS, 1954; GROEN, 1950) also reveal striking examples of psychogenic asthmatic attacks. Clinical material like this is undoubtedly valuable, but it can never constitute a definite proof of the etiology of the attacks. Most of the evidence is reconstructed from case histories, and many of the recorded observations are incidental and not reproducible. We felt therefore that additional insight might be gained if it were possible to produce, study, and register psychogenic asthmatic attacks under laboratory conditions.

METHODS

The experiments concerning the significance of the psychogenic factors in asthma were combined with an investigation into the role of allergic factors. Skin and inhalation-sensitivity tests were carried out on thirty-one patients, using ten commonly used inhalants. The inhalation tests were carried out by the technique of HERXHEIMER (1951 and 1952) as modified by ORIE and TEN CATE (1953 and 1954). In this method the vital capacity of the patient is registered spirographically every 4 min. The allergens are nebulized in an atomizer by means of a constant flow of oxygen. The aerosol is administered to the patient through rubber tubing and a glass-tube mouthpiece. The inhalation test is considered positive when the vital capacity decreases by more than 10 per cent, and if the curve registering this decrease has a regular course in the succeeding determinations.

The investigation of the effect of psychological stimuli was made with twelve of these thirty-one patients. In these experiments we also used the vital capacity as the parameter of the patient's condition. It is admitted that the registration of vital capacity as a yardstick of asthma is not ideal, but it has the advantage of simplicity; moreover, by using the same measurement technique during the tests with allergological and psychological stimuli, it made the results of the psychological and the allergic tests comparable.

* Paper given before the First European Conference of Psychosomatic Research, London, April 1955.

† From the Second Medical Service of the Wilhelmina Gasthuis in Amsterdam. These researches were supported by the Rockefeller Foundation and the Health Organization of the Netherlands Foundation for Applied Scientific Research.

A base line was obtained by observing the patients, and registering the vital capacity every 4 min for a period of time without the application of stimuli. Then the patients were exposed to a certain emotional stress. During the whole experiment the vital capacity was determined every 4 min; only occasionally a single determination had to be omitted when a too-severe attack followed the stimulus. The psychogenic provocation test, like the inhalation test, was considered positive if it was followed by a reduction in vital capacity of more than 10 per cent of the mean of the base-line values, providing the curve recording this decrease had a regular course in succeeding determinations.

The emotional stimulus used in these tests was selected from the history.

When asthma patients are questioned about the causes of their attacks, most of them give a history pointing to heterogeneous causative factors; e.g., inhalation or ingestion of certain substances, the weather, circumstances connected with the patient's occupation, the season of the year, or the time of day. In addition, various emotional states may be blamed. Most patients volunteer this information upon superficial inquiry without any inhibition. This does not apply to situations of a somewhat bizarre character, about which the patients express themselves only if the physician inquires after these without signs of prejudice. The following enumeration gives some of the statements obtained from our patients after they were encouraged to talk freely about the cause of their attacks:

A female patient *A* gets a sense of constriction merely by *looking* at dust, but only during the hay-fever season.

One asthmatic boy *B* becomes dyspnoeic when the sun shines into his room; he then sees the dust particles float in the sunlight. When there is no sunshine, he has no symptoms in the same room.

Another female patient *C* became dyspnoeic when listening to radio speeches by a certain highly-placed political person or to the broadcast of a children's choir, or when she heard the national anthem.

Patient *D* gets a sense of constriction when her back gets cold at about waist level. Rubbing of her back by her husband causes her attack to disappear.

Two ladies *E F* told of becoming nervous when knitting; they would start knitting faster and faster until they had to put down their work on account of an oncoming attack of dyspnoea. *F* also gets an attack when something catches her interest, e.g., a waterfall or a bicycle-race.

A jewellery salesman *G* frequently becomes dyspnoeic when lifting his sample bag.

A female patient *H* gets an attack of asthma whenever she uses an elevator.

A young woman *J* feels "suffocated" when she visits her father's grave, but only when her mother is there too.

Another female patient *K* stated that she was so hypersensitive to aspirin that merely watching someone else swallowing an aspirin tablet gave her a feeling of suffocation. The noise of the sheet-iron workshop below her flat had the same effect.

Two other patients *L M* stated that looking at a goldfish in a bowl caused an asthmatic attack. Both these patients reacted in a similar way when watching a bird in a cage, one of them *L* also when she saw a prison-van.

Patient *N* gets asthma when she smells a certain perfume, sees a picture of a horse, or reads stories of cruelty or disaster in the papers. She has also had attacks when someone touched her neck, or when she had a fear of height.

Hearing her mother use the front-door key, entering the street where she had once lived with her now-divorced husband, seeing a picture of an asthmatic child, others interfering with her running the household, caused attacks in patients *L*, *O*, *P*, and *Q* respectively.

Patient *R* got an attack whenever she *wanted* to go to the town of Enschede in the Netherlands.

The occurrence of these and similar data in the history is not exceptional. The above list was obtained from eighteen out of twenty-four consecutive patients, who were encouraged to tell their own observations freely.

These anamnestic data formed the starting-point for the observations reported in this paper, for a number of the situations described above lent themselves to reproduction under laboratory conditions.

This was done in twelve of these eighteen patients. All patients had either been admitted to the Second Medical Service of the Wilhelmina-Gasthuis, or had been referred to us for allergological examination. All had bronchial asthma to serious degree.

RESULTS

The results of the psychological provocation tests can be classified in three groups:

Group 1 (six patients) did not react at all when exposed to the artificial imitation of the "asthmatogenic" situation.

Group 2 (three cases) showed a transient decrease of vital capacity accompanied by minor symptoms and signs.

In group 3 (three patients) frank asthmatic attacks occurred together with a considerable decrease in vital capacity.

Group 1 (*Patients A, B, C, D, E, G*)

Showing a well-sealed glass container with thick flakes of dust to patient *A*, blowing an aerosol of physiologic saline and house-dust extract in a strong beam of light into the view of the boy *B*, and reproducing on a gramophone a speech of the politician who used to bring patient *C* into an emotional state, had no effect on the vital capacity or the clinical status of these patients. Patient *D* was not influenced by placing an icebag on her back. In patient *E* the base-line vital capacity was too irregular to allow estimation of the influence of knitting. No attack of dyspnoea was observed when she was asked to knit before us. Neither was there a reaction when patient *G* handled his jewellery samples in the laboratory.

Group 2 (*Patients H, I, K*)

Patient *H* had told us that she had asthmatic attacks when she used an elevator. Figs. 1 and 2 illustrate the reactions of the vital capacity during the experiments. First she was shown the picture of an asthmatic child which had produced an asthmatic attack in patient *P*. It had no influence on her. She agreed to make a short trip in an elevator. This caused a transient reduction of the vital capacity, with slight dyspnoea, which could be reproduced. Walking from the laboratory to the elevator and back had no influence, nor was there any reaction when she stayed in a dark cupboard. Allergens in the air of the elevator could not be held responsible for this effect, because on the next occasion there was no reaction when she sat on a chair in the elevator which did not move. During these experiments the patient spontaneously recounted emotional stories, a dream, and how she used to be locked up in a cupboard by her mother.

Patient *I* showed a transient decrease of vital capacity of 17 per cent after being shown a picture, of a man mourning at a grave, which reminded her of her father's death. She then told us about the emotional events connected with his death and burial. At that time she had had a very severe attack of asthma.

Patient *K* got a transient but reproducible decrease of vital capacity up to 21 per cent when she saw the experimenter swallow a tablet of calcium lactate from a wrapping of aspirin.

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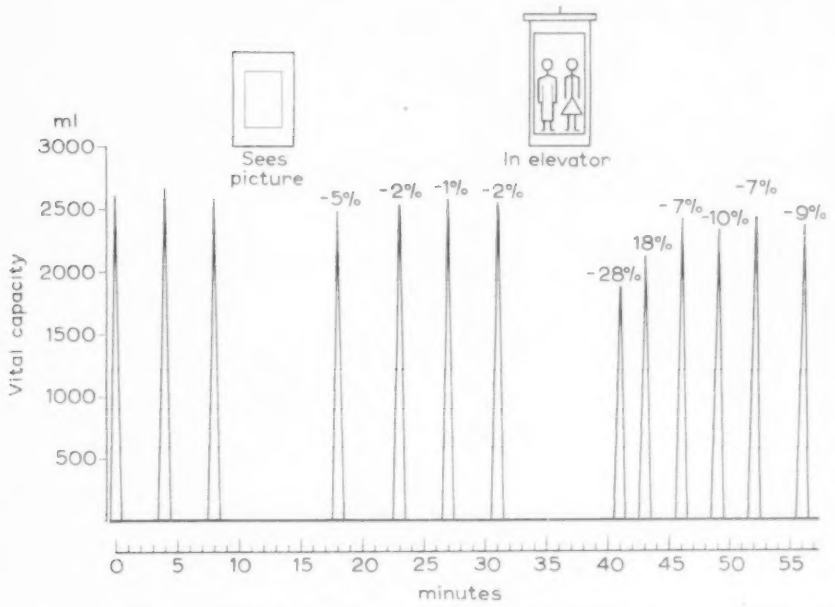

FIG. 1.—Patient *H*. No effect on looking at a picture with emotional contents. Drop in vital capacity after going up and down in an elevator for a few minutes.

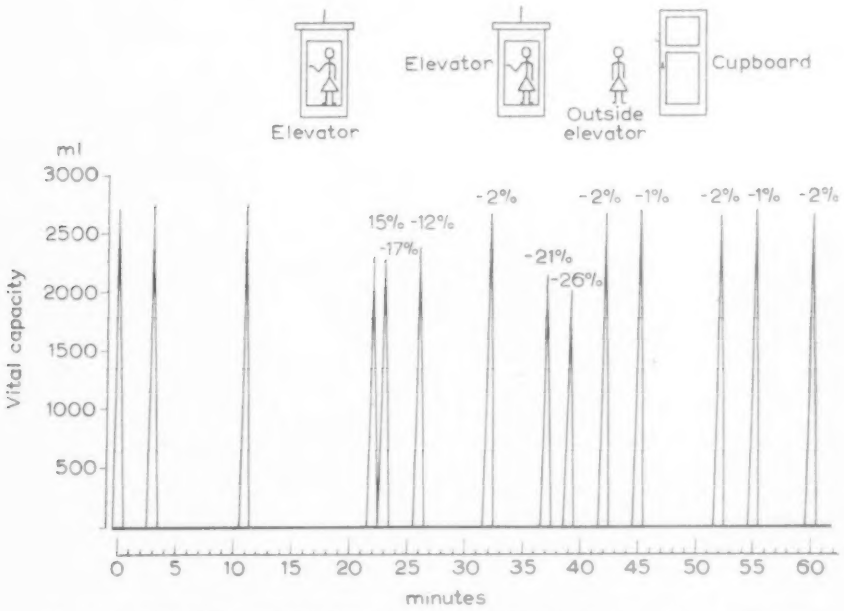

FIG. 2.—Patient *H*. Reproducible drop in vital capacity after staying a few minutes in an elevator between two floors. No effect when standing before the open elevator or in a closed cupboard.

Group 3 (Patients L, M, N)

In this group the decrease in vital capacity after emotional stimuli was more pronounced and prolonged, and accompanied by a clinically clear-cut asthmatic attack.

Patient *L* had told us that she got an asthmatic attack from looking at a goldfish. After a baseline had been obtained, a goldfish in a bowl was brought into the room (Fig. 3). Under our eyes she developed a severe asthmatic attack with loud wheezing,

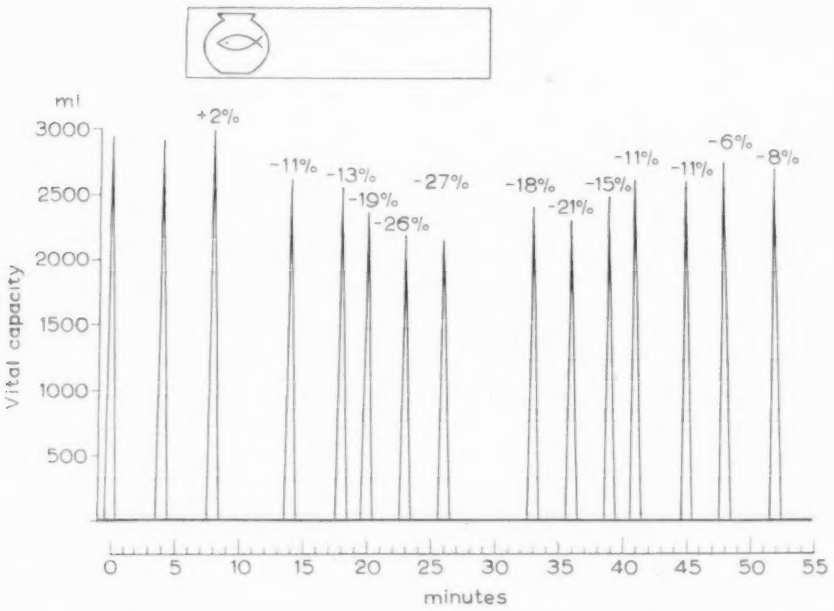

FIG. 3.—Patient *L*. Severe attack of asthma with fall in vital capacity after looking at goldfish in bowl. Disappearance of symptoms and signs after removal of the object.

followed by a gradual remission after the goldfish had been taken from the room. During the next experiment the goldfish was replaced by a plastic toy which was easily recognized by the patient as such (Fig. 4), but a fierce attack resulted (Fig. 5). Upon this she told the investigator the following dream, which she had had after the preceding investigation.

In her home stood a big goldfish bowl. On a shelf high up near the window were her books. In one of them she wanted to read why goldfishes cause asthma. She climbed on a chair and reached for the book, but it was too high. She lost her balance and fell into the goldfish bowl. She gasped for breath behind the glass. The fishes swam around her. Her neck was caught in a streak of water weed. She awoke with an attack of asthma. She also remembered suddenly how when she was a child her mother threw away her bowl of goldfish, which she loved so much. The patient had saved her pocket-money to buy them. Mother threw the fishes into the water closet and flushed them through.

During a third experiment (Fig. 6) even looking at the empty bowl was followed by a severe asthmatic attack. This time there was no remission after the bowl was taken

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FIG. 4.—The toy goldfish in the bowl.

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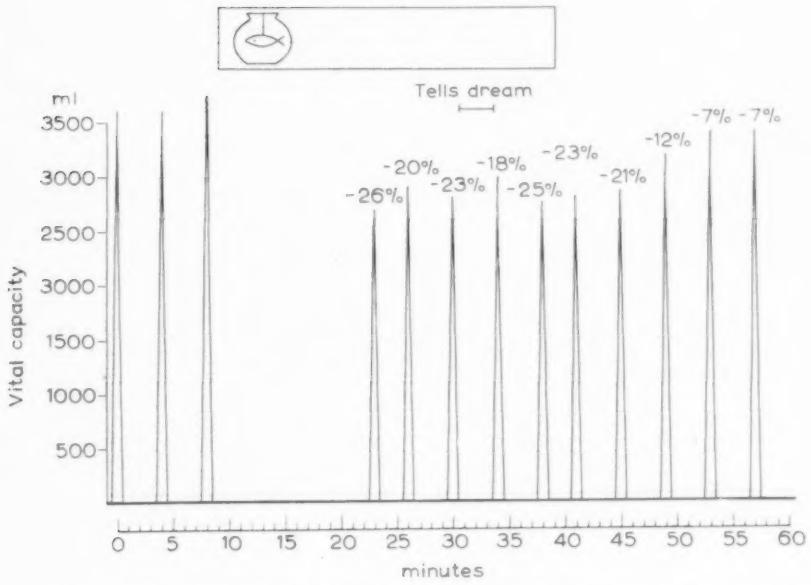

FIG. 5.—Patient *L*. Attack of asthma with decrease in vital capacity, on looking at the toy goldfish in the bowl. Followed by recovery.

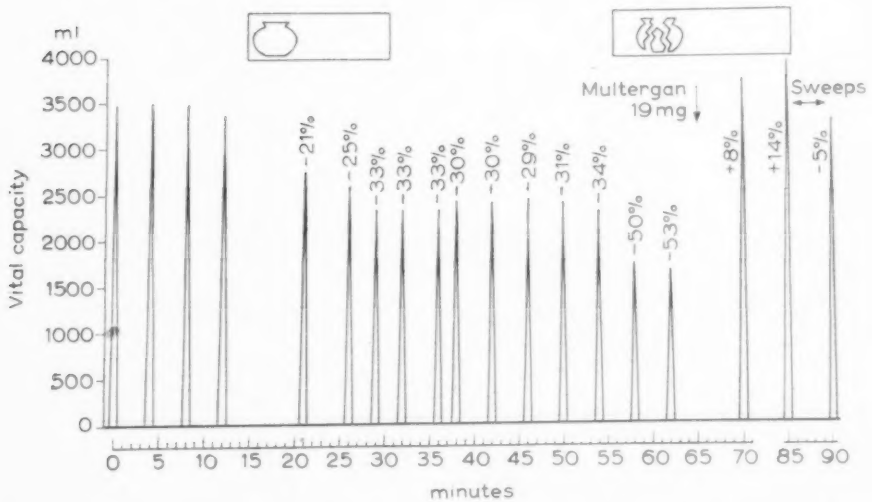

FIG. 6.—Patient *L*. Severe attack on looking at the empty bowl, increasing in severity after the investigator shatters the bowl in pieces on the floor. Prompt reaction of this attack to thiacinamine.

from the room. The investigator in an attempt to break through the patient's reaction threw the bowl into pieces on the floor. "That is exactly what my mother did," she exclaimed, "she threw the bowl into pieces into the dustbin." The dyspnoea increased still further, so that it became necessary to interrupt the attack by an injection. The patient insisted on sweeping the pieces together herself. After she had done this, the vital capacity was again decreased.

This observation could be almost duplicated in patient *M*. Fig. 7 shows the effect of the first exposure to the sight of the goldfish. During the base-line period this patient

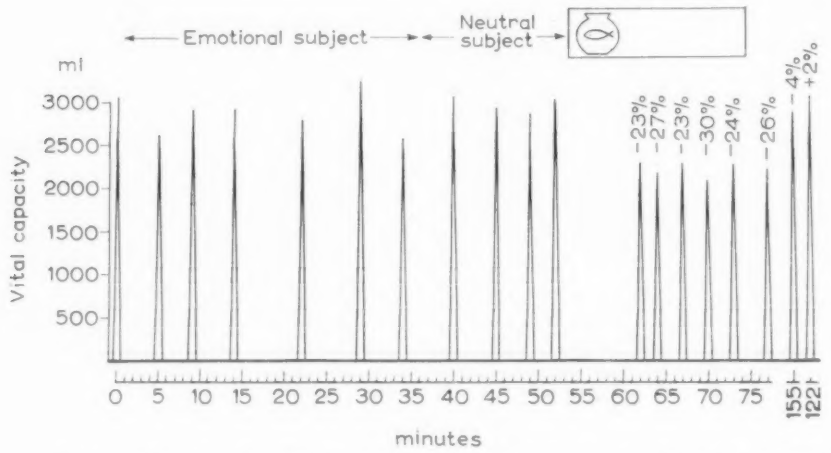

FIG. 7.—Patient *M*. No effect on vital capacity of discussion on emotional subject. Severe attack of asthma with marked decrease in vital capacity on looking at goldfish in bowl.

began to talk about one of her greatest actual difficulties, viz., her son's homosexuality. She showed great emotion, and wept between and even during the vital-capacity measurements, which gave them a somewhat irregular value; however, there was no progressive drop. After changing the topic, a more regular base-line was obtained and the bowl with the goldfish was brought in. Within a few minutes the patient developed an excited behaviour, reproaching the doctor for keeping the poor creature imprisoned in a bowl. She could not get away from the idea that the creature was suffocating and gasping for breath behind the glass.

In our presence she developed a severe attack of typical asthmatic dyspnoea with loud wheezing. During the exposure to this situation she suddenly recalled her first attack of asthma which had occurred eight years earlier than she had hitherto remembered. It started when her husband, a butcher, had made her mop up the blood of a slaughtered calf from the floor, just after her marriage. Upon this a violent emotional discharge followed, accompanied by an increase in dyspnoea with severe cyanosis. After the bowl was taken away and the patient reassured, the vital capacity returned to its base-line level.

The exposure to the plastic toy goldfish (Fig. 8) left her slightly amused for about three minutes. But eight minutes later the vital capacity had dropped to 29 per cent and she was in a severe attack of asthma, during which she expressed strong self-reproach: "Fancy my choking because of that silly toy thing. It isn't even alive."

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She managed to draw herself together somewhat, and suddenly remarked that she was now sure she would not attack her brother-in-law, who had approached her sexually. After this the attack stopped. She then told the emotional story of her struggle against her family to keep the butcher's shop going after her husband had become an invalid, and after his death. After having unburdened herself about this, she recovered completely, the vital capacity increased above base-line value, while the bowl was still standing in front of her.

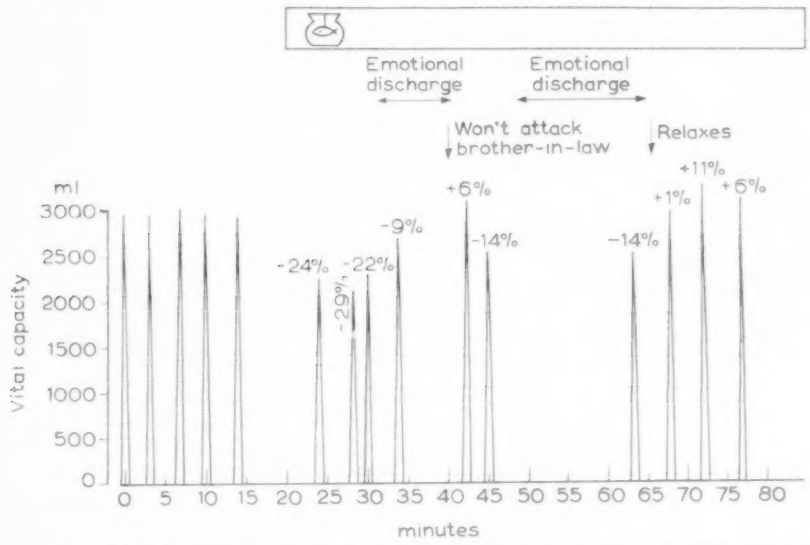

FIG. 8.—Patient *M*. Severe attack of asthma followed by emotional discharge after looking at the toy goldfish in the bowl.

The third patient in this group, *N*, reacted in a similar though somewhat less violent way when asked to look at the picture of a horse (Fig. 9.) and at two sensational reports of a different nature in a well-known illustrated periodical. While wheezing, she produced strong emotional discharges and told traumatic life experiences, which up to this moment she had never revealed to anyone. Similar emotional discharges followed after she was exposed to the smell of the perfume to which she regarded herself as hypersensitive, after she looked down the staircase from the second floor, and after feeling hands being laid around her neck. But from these stimuli she got no asthmatic attacks.

DISCUSSION

In the course of these experiments it was possible to register a decrease in vital capacity, associated in some cases with attacks of typical asthmatic dyspnoea, after the exposure of asthmatic patients to certain emotional environmental stimuli which were chosen from their history. The interpretation of the results as examples of psychogenic attacks rests not only upon the exclusion of other causes, but also on the marked emotional response that was elicited by the exposure. Consequent to the provocation tests these patients related traumatic life experiences, emotional phantasies, and disturbing dreams. No attempt will be made to give a psychiatric interpretation of these observations, but in a number of instances it was quite obvious

that the environmental asthmatogenic stimulus was associatively related to former traumatic life experiences.

The clinical picture of the patients during these psychogenic attacks was indistinguishable from "spontaneous" attacks or from attacks provoked by the inhalation of allergens. They could be aborted by the administration of thiacinamine or isoprenaline.

The positive results were reproducible in five out of six patients who reacted. The positive response in the sixth patient *I* was not controlled for reproducibility for psychological reasons; it was felt that showing this patient the picture of the graveyard for a second time was not justified from a medical ethical standpoint.

The six failures to obtain a psychogenic response are of some interest. The patients *A*, *B*, *C*, and *D* volunteered the information that the experimental condition did not resemble closely enough the circumstances under which their attacks had "naturally" occurred. Patient *E* was quite surprised that she got no attack after knitting for an hour in the laboratory. The attacks of the jewellery salesman *G* on handling his sample-bags may well have been connected with a greater amount of physical effort during his actual work, or with more emotional tension while visiting his customers.

In a similar series of provocation tests where patients were tested for their reactions to the inhalation of allergens, positive reactions were obtained in about an equal percentage, viz., in nine out of thirty-one cases. These percentages of positive and negative provocation tests naturally do not allow an estimate about the relative importance of psychological or allergic factors in the production of the attacks occurring naturally in asthmatic patients.

Of particular importance seems the observation that a high intensity of emotion in itself was not sufficient to produce an attack in these patients. Patient *M* for example was markedly emotional when she discussed the difficulties she had with her homosexual son. However, this gave her no asthma, whereas looking at a goldfish produced a severe attack. Patient *N* was emotionally very upset when exposed to the smell of a certain perfume, when she felt the hands round her neck, and when she felt afraid of the height. She told about traumatic episodes connected with these stimuli, but her vital capacity did not react. Looking at a picture of a horse and at a sensational newspaper report caused no greater display of emotion, but after each of these stimuli an asthmatic attack followed. It was repeatedly observed during these and other studies that the sympathetic discussion of traumatic experiences with a doctor, although often producing emotional reactions, seldom caused a decrease in vital capacity. It seems as if the emotional setting must not only have a certain intensity to produce an attack, but must also be of a more or less specific quality. Our observations so far are too limited in number to allow a more precise definition of this specific quality involved.

The exposure to these asthmatogenic situations was often followed by the reproduction of much more abundant factual and other pertinent information than could have been obtained in the same time during an ordinary interview. It is possible that this way of obtaining information and producing emotional discharge opens up new perspectives for psychotherapeutic efforts along this line.

When we modified the experimental situation we were especially impressed by the fact that, in some of the experiments, the conscious knowledge of the artificiality of the experimental situation did not prevent the onset of an asthmatic attack. Patients *L* and *M* had a severe attack of asthmatic dyspnoea on looking at a toy goldfish, much

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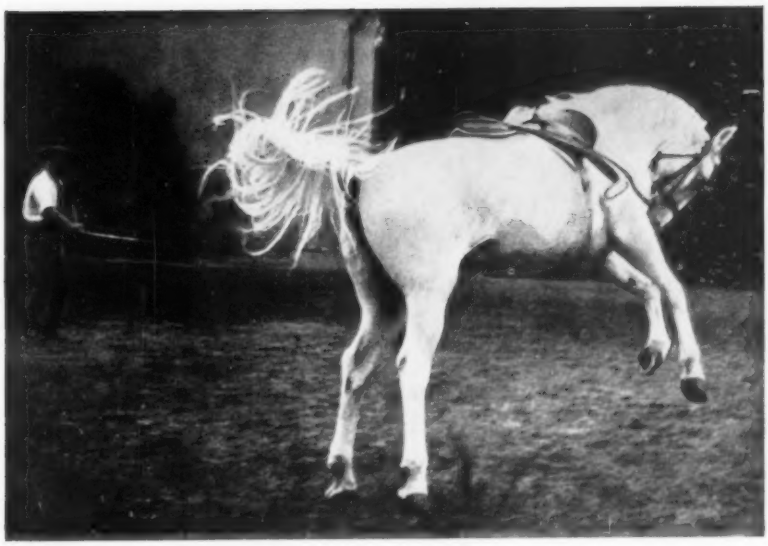

FIG. 9.—Looking at this picture caused an attack of asthma, followed by emotional discharge, in patient *N*. This could be reproduced.

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to their own astonishment. Later they felt self-reproach and powerlessness. In another series of experiments, to be reported elsewhere (DEKKER, in preparation), we observed the same inability to prevent an attack by a conscious effort of will, even when it was provoked by a stimulus which was obviously innocuous and without "organic" or "logical" significance so far as the patient could judge. We are inclined therefore to bring the phenomena described in this paper in line with the process of acquired conditioning (NOELPP, 1952). Experiments to investigate this problem further are now in progress.

Our results also seem to shed some light on the question as to whether asthmatic patients can be classified into an "allergic" and a "psychic" category (POLLNOW, 1929; WITTKOWER, 1932). Two patients in this series, who had shown a positive response to psychogenic stimuli, reacted also to the inhalation of one or more extracts of allergens. Patient *L* got asthmatic attacks and a decrease in vital capacity after the inhalation of extracts of moulds and house-dust, patient *I* after pollen extract. Control experiments ruled out the possibility of psychological factors in these observations. In this, as in other work (BASTIAANS, 1954), it has been possible therefore to demonstrate that in at least some asthmatic patients attacks can be provoked both by the inhalation of allergens and by psychic stimuli. For this reason our experiences do not seem to make it likely that such a classification is justified, and another explanation for the partly psychological, partly allergic genesis of asthma will have to be looked for (BASTIAANS, 1954).

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 68 to 74. Pergamon Press Ltd., London

SOCIO-PSYCHOLOGICAL ASPECTS OF PEPTIC ULCER*

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INTRODUCTION

SOCIO-PSYCHOLOGICAL studies are only one of the different approaches towards the problem of peptic ulcer and therefore, of course, can reveal only one aspect of the whole complex, namely the circumstances connected with the problem of the precipitating situation. Such investigations in patients produce many difficulties, mainly because we have to adapt the terms and concepts of sociology to psychology and medicine (NORTON, 1948; RUESCH and BATESON, 1951; SIMMONS and WOLF, 1954). This is also one of the reasons why our results may need to be revised in some particulars.

A special difficulty for our task is inherent in the problems of translation. For instance, the terms "culture" and "civilisation," both of fundamental importance in sociology, have different meanings in English and in German. In the Pocket Oxford Dictionary under "culture" we find the reference: "see also 'kultur'", and we learn that this kultur means "civilization as conceived by the Germans." Another difficulty concerns the German word "Societät", which we have tried to translate as "community" or "group," although the meaning is not quite the same. So we must ask for the reader's understanding and patience.

MATERIAL AND METHODS

An investigation was made on forty-five men of different professions, ages, and education. All suffered from peptic ulcer, radiologically verified. We obtained in all cases a very detailed biography, in which the main accent was focused on the question, in what way did the patient react to his different life situations, and what were his emotional reactions to these situations. A similar investigation of women is still in progress.

The age at the time of the investigations, the age at the onset of the illness, and the duration of the disorder are shown in Figs. 1–3.

At first we did not intend to focus on socio-psychological questions. This happened during the course of the investigation, when it transpired that *voluntary exclusion or forced expulsion from a community or group coincided, with astonishing frequency, with the onset or the relapse of peptic ulcer.*

Three short extracts from our case histories may illustrate this fact:

(1) The second son in an old farmer's family, as such without the rights and the duties of the heir of the farm, becomes engaged to a poor girl with the consent of the whole family. This situation changes completely when the father and the eldest son die within a few months: convention rules that the heir to a farm must marry a farmer's daughter. His refusal to separate from his intended bride causes his ostracism

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from the whole family and the servants. In this situation he develops his ulcer.

(2) A girl of 19 from a great, patriarchal family in Holstein marries a Bavarian. A few weeks after her move to the south of Germany, where she is considered as

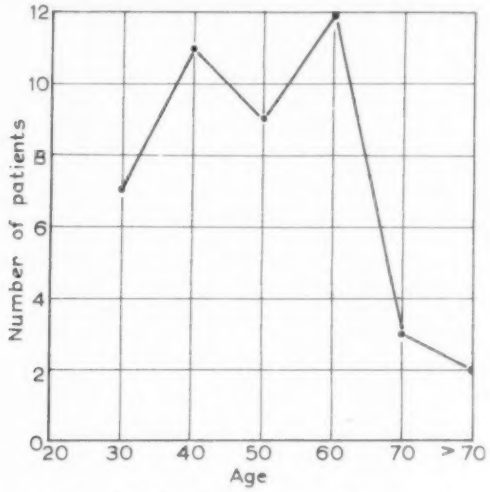

FIG. 1.—Age of patients at the time of examination.

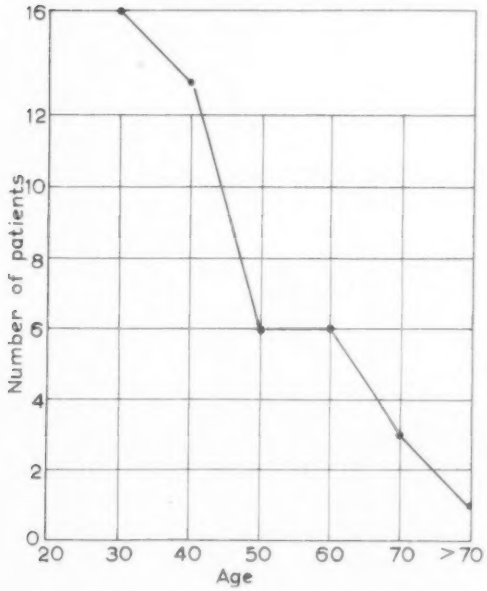

FIG. 2.—Age at the onset of the illness.

"Prussian"—a name used by the Bavarians to express their dislike of all north Germans —she comes to our hospital with a fresh peptic ulcer.

(3) A workman aged 25 lives in the best of relations with his team-mates on his job. They all share the very irregular meals, and the evenings are spent together. His

marriage brings an end to this way of life and tears him out of the circle of his comrades. After the beginning of a regular life with regular meals, his peptic ulcer starts and remains with frequent relapses until the outbreak of the war. Called to the army he enters again a circle of comrades and again maintains the best relationship with them. Under these circumstances he remains without complaint during the whole war, in spite of severe strain and malnutrition.

After the end of the war, with a regular life and good and carefully prepared food, his ulcer returns. The whole thing is mysterious to him: at home with a careful diet,

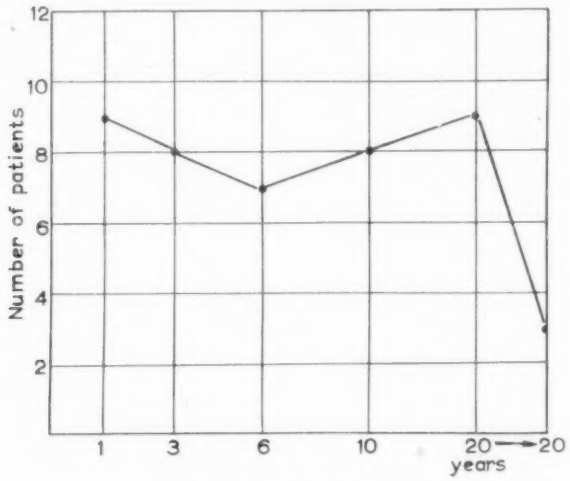

FIG. 3.—Duration of symptoms.

he is ill. Only during periodical work abroad, when eating in a pub with his fellow-workers, does he feel well, and is able to eat practically everything.

In only two of the forty-five cases was the ulcer not preceded by similar situations. In the remaining forty-three patients, the cessation of relationship with any community in which they felt accepted and appreciated was of striking significance. Twenty-three declared spontaneously that under such circumstances they were overcome by a feeling of anxiety and insecurity, for which they could give no explanation.

In Fig. 4 we have tried to give a synopsis of the different situations preceding the development of peptic ulcer.

In forty-three cases the first symptoms started after isolation from a community, which had been experienced as a protective one. In twenty-nine cases this was a co-operative community of equals, a team of workers, comrades, a circle of professional or business friends. In eleven cases it was the family or the clan. In two cases it was the protection given by a superior, and in one case just the profession as such. The time which elapsed between the onset of the disturbance in the relations with the community and the onset of ulcer symptoms varied from eight days to two months. In one patient only it was six months.

We are aware that this attempt to classify the different forms of community is only of preliminary value; furthermore, there is much overlapping. Nevertheless, it reveals one important fact: a change in the personal relations with a close individual, e.g.,

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acquisition, or loss, of a relative or a close friend, is of significance in our patients only in those cases where this change led indirectly to separation from the community.

Fig. 5 shows the situations preceding the eighty-three registered relapses or periods of relapses after a symptom-free interval.

In eleven cases we found no connection with social disturbances. Twenty-three times the relapse occurred after an isolation from a community of equals, ten times after isolation from family or clan, once after the loss of protection from a superior, and twice in a situation in which the position as a superior was jeopardized.

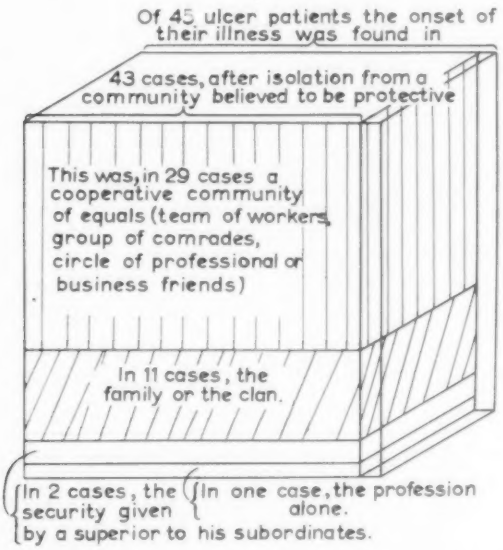
Of 45 ulcer patients the onset of their illness was found in
43 cases, after isolation from a community believed to be protective
This was, in 29 cases a cooperative community of equals (team of workers, group of comrades, circle of professional or business friends)
In 11 cases, the family or the clan.
In 2 cases, the security given by a superior to his subordinates.
In one case, the profession alone.

FIG. 4.—The different situations preceding the development of peptic ulcer.

Of special interest is the next group, where the complaints concerned men who were once isolated from their old community and were now unable to get real contact with a new one. The new community was no longer emotionally conceived as giving security and protection; on the contrary, it was experienced as strange, threatening, sometimes even as hostile. This was especially the case when the patient developed the feeling of being unjustly treated, or if demands were not fulfilled. A typical situation of this kind is the struggle for a just pension.

Concerning the attitude towards the community, we believe that two groups can be distinguished:

(1) People who easily join groups of similarly minded men. In those people the feeling of isolation begins if such groups are not available.

(2) People who have difficulty in getting into contact with others. These conditional individualists try to get support from more anonymous organizations. There they try to earn protection by a special professional efficiency. In these cases isolation begins when this fails, or if the organization fails.

People of the first group often demonstrate the behaviour of the second, if they do not find a new community to join.

Both these groups apparently have in common a deep dependence on the feeling of personal security within a group. The growth to maturity of the ego and the possibility to feel one's own personal value seem to be disturbed. A patient of this kind often gave the impression of a hermit crab, which can only live when it hides its body in a shell.

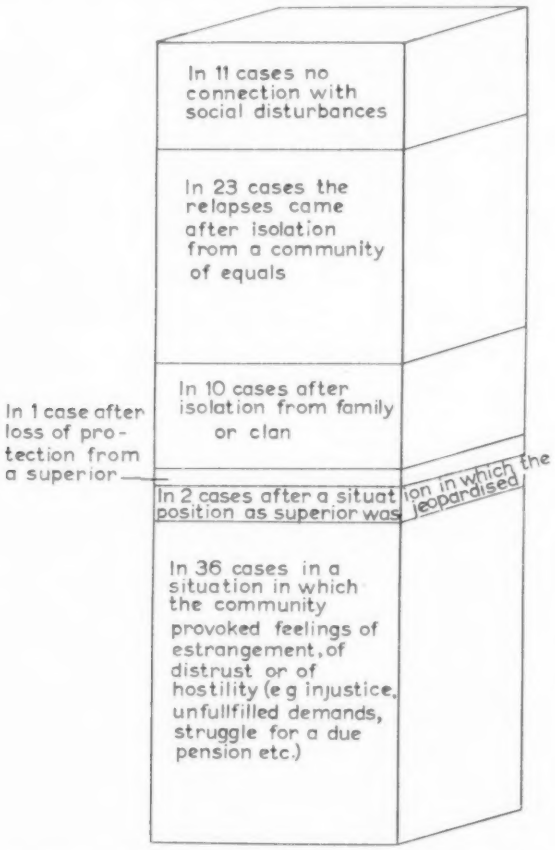
In 11 cases no connection with social disturbances
In 23 cases the relapses came after isolation from a community of equals
In 10 cases after isolation from family or clan
In 1 case after loss of protection from a superior
In 2 cases after a situation in which the position as superior was jeopardised
In 36 cases in a situation in which the community provoked feelings of estrangement, of distrust or of hostility (e g injustice, unfullfilled demands, struggle for a due pension etc.)

FIG. 5.—The different situations preceding the relapses of peptic ulcer in eighty-three relapses.

The change of the shell is for them a most critical situation, in which they are especially vulnerable.

This impression obtained from socio-psychological studies fits well into the analytic concept of early oral frustration (ALEXANDER, 1950; DUNBAR, 1947, 1948; HOFMEIER, 1955; SCHWIDDER, 1951) as being responsible for the small and fragile fundament of confidence, from which many ulcer patients look onto the world. In this connection it seems remarkable that the sphere of nourishment was often closely connected with the community sphere: we found again and again that people could stand even panic and malnutrition if they harmonized with their community. Under isolation many had complaints even when on a special diet.

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In consequence, we believe the situation of being isolated from a community to be rather specific for the development of peptic ulcer. After having experienced deadly danger, patients showed other somatic disturbances, but no ulcer (Fig. 6).

Catastrophes followed by destruction of economic existence, such as bombed houses, or expulsion from home during or after war, did not produce any somatic symptoms. These events did not lead to isolation—on the contrary they resulted in

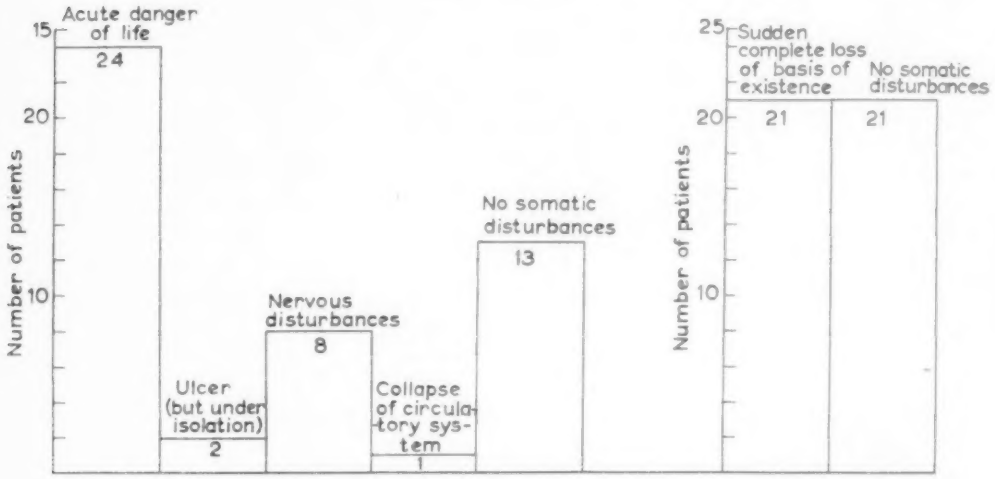

FIG. 6.—The correlation between situations of acute danger, loss of basis of existence, and somatic disturbances.

inclusion in the great community of fellow-sufferers sharing the same fate at the same time. That a change in individual relations was not followed by ulcer symptoms has already been pointed out.

DISCUSSION

We believe that knowledge of the significance of social isolation for ulcer development may also perhaps help us to improve our comprehension of the strange statistical differences between the frequency of ulcer at different times (ALSTED, 1953; GLATZEL, 1945; ILLINGWORTH, 1944; PETRÉN, 1945, 1951; TIDY, 1943) and among different populations (ALSTED, 1953; DOLL and JONES, 1951; EAGLE and GILLMAN, 1938; EHRSTRÖM, 1950; VINT, 1937-38). If we agree that modern civilization tends to dissolve many of the existing social structures, (HALLIDAY, 1945) we may arrive at the working-hypothesis that this development is one of the reasons for the increase of ulcer in the last forty years. It explains also why this increase concerns especially large modern cities, whereas the ulcer rate in rural districts and among primitive races remains relatively low.

Perhaps this hypothesis can add to our understanding of the striking fact that the increase in ulcer frequency during the last war in Germany was not found among the front-line troops but among the home services and the services behind the lines (KALK, 1945) and the even more striking fact that the ulcer rate decreased in concentration camps, but increased after the liberation of the prisoners (GROEN, 1947; KRAL, 1951; PFLANZ and UEXKÜLL, 1952).

Up to the present this interpretation must be taken as preliminary. We are aware that the number of our investigations is still too small for final statements. Also, the lack of a representative control group must be noted. Another restriction lies in the fact that our investigations refer only to Germans and those living under the more or less abnormal sociological conditions of the last twenty-two years. But if our report will stimulate more investigations along this line it has fulfilled its purpose.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 75 to 83. Pergamon Press Ltd., London

LIFE SITUATIONS, BEHAVIOUR, ATTITUDES, EMOTIONS, AND RENAL EXCRETION OF FLUID AND ELECTROLYTES*—I†

METHOD OF STUDY

W. W. SCHOTTSTAEDT, M.D.,‡ W. J. GRACE, M.D., and H. G. WOLFF, M.D.

THE present investigations were undertaken to study the normal range of variation in renal excretion and to ascertain whether renal mechanisms for the control of fluid and electrolyte excretion might be activated not only by changes in the physical environment but also by symbols of danger or situations involving interpersonal and social relations which the individual perceived as threatening.

Variations in the excretion of water and electrolytes by the kidney have previously been studied under a variety of circumstances, including extremes of water and salt ingestion or deprivation, light, moderate, or vigorous muscular activity, or during recumbency and sleep. Such studies have usually been carried out with the subject fasting and in a "basal state" in the laboratory. However, the study of renal excretion in association with changing life situations, adaptive behaviour patterns, and emotional responses can best be carried out as these situations develop during the ordinary "routine" of living. To perform such studies requires knowledge of the relative importance of fluid and salt intake or of muscular activity and body position on renal excretion of fluid and electrolytes. Only then can the relationship of life situations to renal excretion of fluid and electrolytes be interpreted.

METHOD

Approximately four hundred collection periods were analysed in five subjects during life situations evoking a variety of adaptive patterns, including altered behaviour, attitudes, emotions, and feeling states. Observations were made under circumstances of ordinary daily work, with no specific restrictions on food or fluid intake nor in the amount or intensity of muscular activity.

The five subjects were studied for periods of fourteen to forty-six days. All urine voided during this time was collected and "pooled" into four specimens each day. These specimens were obtained upon arising in the morning, just before lunch and supper, and before retiring for the night, thus dividing the day into four unequal periods. Three of these began with a meal and included the four to six hours of excretion subsequently; one was wholly a period of recumbency and sleep. Records of food and fluid intake, events, activities, and emotions or feeling states were kept

* From the Department of Medicine of the New York Hospital and Cornell University Medical College. This study was made possible in part by grants from the Commonwealth Fund and the U.S. Public Health Service.

† Part I represents the first of a series of five papers which will be published consecutively.

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with meticulous care. These data were not correlated with the laboratory data until completion of each study. Four of the subjects were healthy physicians who understood the need for accurate and detailed records, while the fifth was a research worker. Three of these subjects were men; two were women.

Calculations of intake of water, sodium, and potassium were made from the diets recorded, using tables in Bridges' Food and Beverage Analyses by MATTICE (1950). The content of glasses and cups used was measured carefully. Salt added in cooking and at the table was roughly estimated by weighing the amount of salt ejected from the salt cellar with each shake and recording the number of shakes per meal. The error in recorded sodium intake may be higher than 25 per cent; the error in water and potassium intake should be less than 20 per cent. For simplicity, the calculated intakes will be presented as absolute values. This is not intended to imply that an estimated intake of 40 mEq of sodium is significantly different from an estimated intake of 60 mEq.

No restrictions on intake were made. Consequently the composition of meals, particularly the noon and evening meals, varied appreciably from day to day. However, it should be noted that food and fluid were always taken together as a meal; therefore, the data reported cannot be compared with data obtained after ingestion of large amounts of water with the subject fasting. Excretion rates given are averages for a four- to six-hour period after each meal.

Bodily position and the amount of activity were recorded. The majority of daytime observations were made under conditions of light physical activity. Usually, this activity consisted of walking quietly about the house or from one examining-room to another in a hospital clinic.

Data for Subject No. 1 will be presented in detail. She was a healthy woman physician and housewife, twenty-eight years of age, who collected specimens over a period of forty-six days. During this period of observation she was engaged in housework rather than in professional activities. She did not smoke at any time during these studies.

In addition, data will be presented briefly for Subject No. 5, since his level of sodium intake was radically different. He was a 31-year-old healthy male physician doing clinical and research work during the period of study. The data on the remaining subjects were similar to that to be presented for Subject No. 1.

Sodium and potassium were determined using a Barclay flame photometer (FOX, 1951).

RESULTS

Fluid. The correlation of fluid intake at each meal with urine volume during each subsequent period is given for Subject No. 1 in Fig. 1. Since there was ordinarily no food or fluid intake just prior to retiring, night specimens are not included. At intakes below 300 cc, the urine volume varied between 99 and 663 cc; while at intakes above 500 cc, the urine volume varied between 96 and 642 cc. Thus the variations in excretion rates observed covered the same range at low levels of intake as at high levels of intake. An intake of 1500 cc of fluid was associated with an output of 180 cc, while a period with no fluid intake was associated with an output of 663 cc of urine.

Fig. 2 presents data on four of the subjects for morning specimens only. Again, the variation in urine volumes covered similar ranges at low and high levels of intake,

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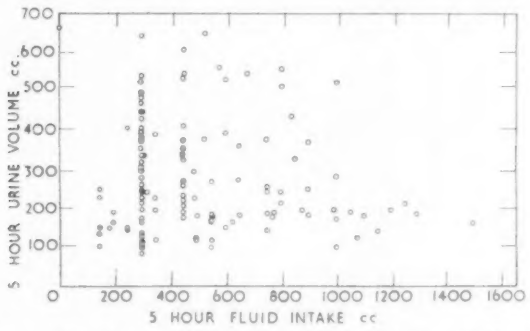

FIG. 1.—Correlation of fluid intake and urine volume in Subject No. 1.

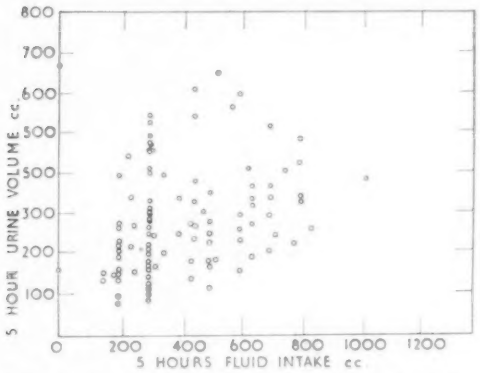

FIG. 2. Correlation of fluid intake and urine volume of morning observations on four subjects.

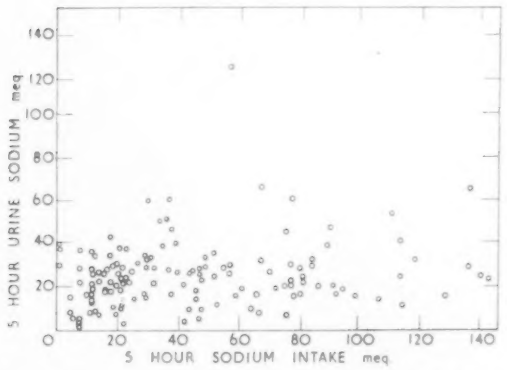

FIG. 3.—Correlation of sodium intake and excretion in Subject No. 1

though low urine volumes were more frequent at low levels of intake. This is more clearly evident when the same data are presented as in Table 1.

TABLE 1.—CORRELATION OF MORNING FLUID INTAKE AND OUTPUT FOR FOUR SUBJECTS

Time	Intake	Number of obs.	Range of 5-hour urine volumes
Morning	0–299 cc	25	75–663 cc
Morning	300–499 cc	43	78–600 cc
Morning	500–1000 cc	34	108–642 cc

Night volumes had a similar range of excretion rates (93 to 558 cc), though no fluid was taken before retiring.

Comment: Since, under the circumstances of these experiments, the range of urine volumes at low and high levels of intake remained similar, fluid intake was not the only determinant of urine volume.

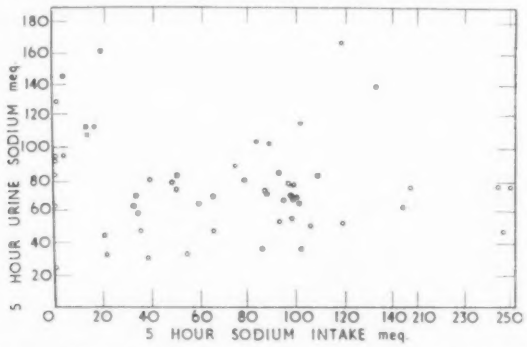

FIG. 4.—Correlation of sodium intake and excretion in Subject No. 5.

Sodium. The data correlating sodium intake at each meal with subsequent renal excretion of sodium are given for Subject No. 1 in Fig. 3. Though sodium intake varied from 0 to 142 mEq per meal, sodium excretion was not closely correlated with these variations. The range in sodium excretion from 5 to 63 mEq with intakes below 50 mEq is not greatly different from the range of 9 to 68 mEq (with one striking exception) with intakes above 50 mEq. On three occasions when sodium intake was negligible, sodium output was in the mid-range. Nocturnal excretion rates were not materially different. They ranged from 8 to 75 mEq. Subjects Nos. 2 and 4 showed similar results.

Fig. 4 presents sodium intake-output correlations for Subject No. 5. He used large quantities of salt, salting his morning toast and adding a teaspoonful of salt to his tomato juice. His average sodium intake during two weeks of observation was calculated to be 297 mEq per day. His average daily output during this same period was slightly higher than this. With a higher average daily intake there was a higher average output, but again there was no direct relationship between immediate intake

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and output. Since this subject ate four meals a day, including one just before retiring, night specimens were included in Fig. 4. Omitting a meal affected sodium output little. Under such circumstances sodium excretion ranged from 21 to 157 mEq, as compared with a range from 30 to 160 mEq following meals which contained up to 255 mEq of sodium.

Comment: As with fluid excretion, sodium excretion varied widely and over approximately the same range whether the immediately preceding intake of sodium had been large or negligible.

Sodium and water. It is shown that sodium can exert a retaining effect on water (SMITH, 1951). Thus in a fasting individual a litre of water will produce a marked diuresis with peak output reaching 10–20 cc/min, whereas a litre of saline will produce a minor diuresis with peak output reaching only 1–2 cc/min. It would seem reasonable therefore to attribute the variation recorded above to the influence of sodium intake on water excretion. To examine this possibility in our data, morning specimens are most useful, since they represent more constant conditions. For Subject No. 1 there were twenty-nine morning observations with a fluid intake of 300 cc; sodium intake varied from 0 to 45 mEq. Table 2 gives the rates of urine excretion at low and high levels of sodium intake in this subject. With one exception, sodium was always present when fluid was ingested during these experiments.

TABLE 2.—CORRELATION OF FLUID EXCRETION WITH SODIUM AND FLUID INTAKE DURING MORNING OBSERVATIONS IN SUBJECT NO. 1

Time	Fluid intake	Sodium intake	Number of obs.	Range of 5-hour urine volume
Morning	300 cc	0–15 mEq (av. = 10)	15	81–534 cc
Morning	300 cc	16–45 mEq (av. = 26)	14	105–489 cc

Urine volumes in this subject showed the same range of variation following ingestion of 300 cc of fluid in the morning, whether the average sodium intake was 10 mEq or 26 mEq. This suggests that the variations observed were not an expression of the water-retaining effect of sodium.

Coffee. Breakfast regularly included coffee. Though intake of coffee remained fairly uniform, the effect of its activity as a diuretic required investigation in interpreting the variations noted above. In twenty-six of the twenty-nine observations recorded in Table 2, coffee constituted all of the 300 cc of fluid. In these twenty-six instances, urine volumes ranged from 81 to 537 cc. Hence the wide variations observed in urine volume were not the result of variations in coffee consumption.

Potassium. The correlation of potassium intake at each meal with subsequent rate of excretion is given in Fig. 5. Again the range of potassium output remained uniform, though with high levels of intake the lower excretion rates occurred less frequently.

Activity and recumbency. Observations were made with the subjects going about their "routine" daily activities. The effects of variations in activity on excretion rates should be most evident in a comparison of rates observed during unusual exertion and during recumbency. Table 4 gives these rates of excretion. On three occasions

TABLE 3.—CORRELATION OF POTASSIUM INTAKE AND EXCRETION IN SUBJECT NO. 1

Time	Potassium intake	Number of obs.	Range of 5-hour potassium excretion
Morning	0–5 mEq	21	5–27 mEq
Morning	6–17	25	7–25
Afternoon	0–17 mEq	23	8–21 mEq
Afternoon	17–54	23	10–35
Evening	0–37 mEq	25	5–28 mEq
Evening	38–83	21	10–35

Subject No. 1 spent an hour swimming (Table 4) during the 5-hour observation period. Two of these instances were associated with very slight decreases in rate of urine excretion and one with a moderate increase as compared to overall averages. Sodium excretion was also affected variably. These variations were not consequent on differences in intake prior to the activity. On three occasions Subject No. 1 spent almost the

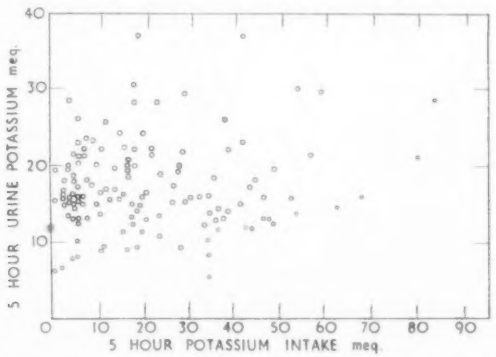

FIG. 5.—Correlation of potassium intake and excretion in Subject No. 1.

entire 5-hour period walking (Table 4). Urine volume and urine sodium excretion varied again without direct relationship to intake, being lower than the average on two occasions and higher on one. Two instances are recorded of hard physical work for a full 5-hour period when Subject No. 1 was engaged in autumn housecleaning (Table 4c). Urine volume and urine sodium excretion were low on both occasions; the variation again cannot be explained in terms of prior intake. On ten occasions Subject No. 1 lay down to take a daytime nap, usually for a two-hour period (Table 4d). Three of these periods were associated with increased urine volume, seven with decreased urine volume. One of them was accompanied by a lower urine volume (0·30 cc/min) than was observed with any of the eight periods of unusually strenuous activity. Six of the periods of recumbency were associated with urine volumes as low or lower than those which accompanied continuous walking for five hours. Sodium excretion varied independently of the immediately preceding intake.

Comment. Though increased physical activity was sometimes associated with decreased urine volume and urine sodium, this was not a constant finding; nor could

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the variations be explained in terms of variation in intake. Conversely, though recumbency was sometimes associated with increased urine volume, this was not a predictable finding; and again the variations could not be understood in terms of variations in intake. These findings demonstrate that some additional factors may override the effects of increased activity as compared with rest and recumbency.

TABLE 4.—CORRELATION OF RATES OF RENAL EXCRETION OF H_2O, NA, AND K WITH PRECEDING ACTIVITY AND INTAKE IN SUBJECT NO. 1

Condition	Output			Intake at preceding meal		
	H_2O cc/min	Na ueq/min	K ueq/min	H_2O cc	Na mEq	K mEq
Average	0·90	95	59	440	43	19
(a) 1-hour swim						
observation 1	1.57	104	52	300	8	3
2	0·82	60	88	900	97	53
3	0·74	139	48	300	34	4
(b) Walking 5 hours						
observation 1	1·33	78	63	300	11	10
2	0·63	108	50	990	76	47
3	0·61	104	67	600	135	80
(c) Hard physical work						
observation 1	0·61	57	49	300	4	7
2	0·32	13	49	850	28	18
(d) Recumbency						
observation 1	1·73	96	63	300	70	21
2	1·19	91	48	650	51	27
3	1·13	133	61	300	0	2
4	0·74	83	50	300	47	20
5	0·63	103	49	200	31	4
6	0·63	96	63	1200	43	28
7	0·58	70	48	450	93	30
8	0·46	72	62	250	60	14
9	0·33	37	47	150	47	7
10	0·30	54	69	500	77	29

24-Hour Balance. That these general formulations hold for periods longer than the 4–6-hour observations already given is indicated by the data in Table 5. The calculated intakes and measured outputs for water, sodium, and potassium are given for each 24-hour period of the 46-day experiment in Subject No. 1. Intake and output were poorly correlated. On the twenty-third day of the experiment, intake was suddenly halved; however, urine volume was doubled and the output of sodium and potassium was increased compared with the previous day. On the seventeenth day, an increase in water intake of 1100 cc was not reflected by any appreciable change in output. The day of highest sodium intake (the twelfth day of the experiment)

TABLE 5.—24-HOUR INTAKE AND OUTPUT OF WATER, SODIUM, AND POTASSIUM IN SUBJECT NO. 1

Day	H_2O cc		Na mEq		K mEq	
	In	Out	In	Out	In	Out
1	2100	1037	184	114	93	68
2	2000	493	125	50	70	51
3	1600	1017	94	111	47	70
4	2150	1186	147	201	52	69
5	1350	970	142	142	43	46
6	1550	1114	143	178	58	46
7	1350	980	109	177	48	52
8	1800	1165	149	190	78	67
9	1300	1287	142	165	66	54
10	1390	1103	107	146	42	65
11	1500	1418	133	129	60	67
12	2040	991	208	129	67	65
13	2165	1476	194	161	96	85
14	890	730	130	114	36	66
15	1950	1141	149	145	52	48
16	1675	1221	97	156	55	34
17	2750	1250	173	184	116	64
18	1275	1870	104	174	39	69
19	1350	870	90	71	48	55
20	2000	787	94	45	78	72
21	1950	1026	177	90	63	65
22	1550	868	185	146	90	62
23	790	1946	87	171	41	66
24	1650	1269	127	108	38	66
25	1825	800	142	98	84	47
26	1100	1338	120	109	42	58
27	1640	1141	153	150	51	49
28	1400	1457	97	189	57	71
29	1500	1581	109	160	79	56
30	1950	683	197	94	84	62
31	2340	1461	170	141	91	67
32	1250	1000	163	135	63	74
33	1200	1148	89	137	40	78
34	2000	1120	120	93	62	50
35	1100	932	100	161	59	72
36	1400	1299	113	145	57	51
37	1365	952	166	89	72	49
38	1625	1225	120	139	90	75
39	1125	1140	109	133	65	79
40	1550	1278	173	111	59	55
41	1450	1476	83	143	84	56
42	1400	1063	103	132	66	69
43	1050	999	142	116	35	66
44	1350	1062	90	90	70	65
45	1565	926	194	173	80	65
46	1550	1910	128	249	89	94
Range	790–2750	493–1946	83–208	45–201	35–116	34–94
Average	1584	1157	134	136	64	63

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showed only an average output. Conversely, the day of highest sodium output (the fourth) was one of average intake. The lowest intake of fluid was associated with the highest output (twenty-third day). Thus 24-hour intake-output figures support the general conclusion that output was not closely related to the *immediate* level of intake.

SUMMARY

The purpose of the present investigation was to study variations in renal excretion occurring during the course of daily activities, and to ascertain the feasibility of studying such variations in fluid and electrolyte excretion under circumstances of ordinary daily "routine" rather than under the limiting circumstances of controlled laboratory procedure. Despite obvious difficulties involved in such a procedure, this type of study proved feasible. Wide variations in excretion rates of water, sodium, and potassium were observed in the five healthy subjects studied. The range of variation observed at any time of day was similar in any one of the subjects whether he had been fasting or had had a high level of intake preceding the collection period. In one subject with sodium intake continuously higher than in the others, sodium excretion was also generally higher. However, sudden and transient changes in intake, whether omission of a meal or ingestion of an unusually large meal, had relatively little effect on the excretion rates observed. Many of the variations observed could not be correlated with changes in intake of water, sodium, or potassium, with activity or sleep, or with any combination of these.

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CONCLUSIONS

1. In five healthy subjects performing their usual "routine" of daily activities and eating an unrestricted diet, wide fluctuations in the renal excretion of fluid and electrolytes have been observed.
2. The range of variation in renal excretion observed in these subjects was similar at low and high levels of intake.
3. Many of the variations observed could not be correlated with changes in intake of water, sodium, or potassium, with activity or sleep, or with any combination of these.

Acknowledgements—The authors wish to thank Drs. ROBERT PITTS, HOWARD EDER, DAVE THOMPSON, and HENRY LAUSON for their helpful suggestions in the conduct and presentation of these experiments.

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A RORSCHACH STUDY OF THE NEURODERMATOSES*

J. M. WHITE, M.D.,† A. M. JONES, B.A., and J. G. INGHAM, Ph.D.

1. INTRODUCTION

ATTEMPTS to find personality traits specific to different forms of psychogenic skin disease have in general been unsuccessful. Positive findings have been reported, however, by STOKES (1932), and KLABER and WITTKOWER (1939), who wrote on the "social inadequacy" personality in rosacea, and by ROGERSON (1937), who dealt with the personality of children suffering from atopic eczema. These findings have never been seriously disputed.

One important source of error in many of these personality studies arises from their being mainly based on subjective impressions. Another is that the number of cases investigated is frequently inadequate for valid conclusions to be drawn. A number of authors have used projection tests as an aid to objective personality assessment, but too often such findings have been incorporated with their subjective appraisement of personality in such a way that the value of objective testing is lost. A few authors have reported Rorschach and clinical findings separately, including LYNCH, HINCKLEY, and COWAN (1945), KEPECS, RABIN, and ROBIN (1951), and STERNBERG (1952) writing on atopic dermatitis, and OBERMAYER *et al.* (1952) on neurodermatitis. Their Rorschach results, however, are difficult to assess, as the test data are inadequately described. The papers of PLESCH (1951) on rosacea and erythrophobia, and LEVY (1952) on neurodermatitis, are the sole known reports in this field in which the Rorschach findings are quoted in adequate detail.

In the present investigation an attempt was made to assess objectively some relevant personality variables. The Rorschach test was applied to a group of patients suffering from various neurodermatoses. All of these had been psychiatrically studied, and in each case an accurate dermatological diagnosis was available. Thus it was possible to relate clinical assessments of personality with the Rorschach findings, and to compare the different psychocutaneous syndromes with greater objectivity than would be possible using the clinical assessments alone.

2. PROCEDURE

The test was administered to 102 cases of psychogenic skin disorder. The cases were chosen from a much larger group referred by dermatologists for psychiatric investigation and clinically studied by J. M. W. The criteria for selection for Rorschach testing were the skin diagnoses and the availability of the patients. The test group was therefore a fairly representative sample of the larger number clinically investigated. It cannot be considered as representative of the neurodermatoses in general, as cases were rarely referred for psychiatric opinion unless emotional factors were fairly obviously associated with the skin condition or a reasonable suspicion existed to this effect.

Of the cases tested, 7 were discarded as they were not easily classified into any of the diagnostic groups. The remaining cases were divided into the following categories: Rosacea (17), urticaria (9),

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seborrhoeic dermatitis (10), pruritis ani (9), pruritis* (8), atopic eczema (5), dermatitis artefacta (5), dyshydrosis (13), and neurodermatitis (19).

The age and sex distribution of these cases is shown in Table 1. With the exception of atopic eczema, which occurred in a relatively young age group, the mean age in each group ranged from 31·8 to 46·1 years. The sex distribution was somewhat abnormal, being, in some groups, considerably weighted to the male side.

As this work was mainly concerned with possible differences between the diagnostic groups, a normal control group was not considered essential to the investigation. Some of the relevant Rorschach data, however, were obtained from a group of anxiety neurotics matched for age with the neurodermatosis patients (see Tables 3 and 4). This group was not included in the analysis of variance (see Table 2).

The tests were given by A. M. J., the only clinical information available to her being that the patient had "neurodermatitis." The method of scoring was taken from KLOPFER and KELLY (1942). Certain scores were chosen as being most indicative of the emotional aspects of personality. These were (1) the number of human-movement responses M, (2) the number of colour responses C, (3) the percentage of pure-form responses $F\%$, and (4) the number of anatomy responses. In addition to these, use was made of various methods, taken from the literature, of scoring the test for a number of traits, namely anxiety, hysteria, tension, hostility, social adjustment, personal adjustment, and neurosis. It should be stressed that, though these scores were used, we do not necessarily accept that they are valid methods of assessing the traits concerned. The aim at this stage was to make objective observations of behaviour in a standard situation. For this reason the "content material" was largely ignored as being liable to subjective bias.

The investigation was concerned with two problems.

(1) Are there differences in personality between the various diagnostic groups, greater than could be expected to arise from sampling errors?

(2) What is the nature of these differences if they exist?

The results enable us to state a fairly definite answer to problem (1) and to formulate hypotheses relevant to problem (2). These two problems will be discussed separately.

3. RESULTS

(i) *Problem* (1)

Frequency distributions were plotted for all the Rorschach variates. Many of these distributions showed a gross departure from a normal curve, and it was not justifiable, therefore, to use a method of analysis which assumed a normal distribution in the parent population. The method chosen was the H test of KRUSKAL and WALLIS (1952), which is essentially an analysis of variance using ranks instead of scores. KRUSKAL and WALLIS suggest that a reasonable approximation is to assume that H is distributed as χ^2 with $C - 1$ degrees of freedom (where C = the number of groups), whenever there are five or more cases in each group. This approximation, therefore, was used here.

Table 2 shows the values of H for each of the variates. The probability of getting these values if the null hypothesis (that all the groups were drawn from the same population) is correct, is shown in column P. From the table it can be seen that there is evidence of differences between the groups in the number of human-movement responses and in the scores for hostility and tension.†

We may conclude, therefore, that there is statistical evidence of *differences in personality between the various diagnostic groups.*

* This group was composed of cases of generalized pruritis. The female members of this group also complained of pruritis vulvae.

† An analysis of variance using the orthodox method which assumes normal distributions in the population was also undertaken for comparison with the H test. The only marked discrepancies between the two methods were for those variates where the distributions departed most noticeably from normality.

TABLE 1.—DATA ON AGE AND SEX

	Number		Ages	
	Male	Female	Range	Mean
Rosacea	7	10	24–54	37·1
Urticaria	3	6	26–51	37·1
Seborrhoeic dermatitis	10	0	21–58	36·0
Pruritis ani	9	0	31–53	42·3
Pruritis	4	4	29–60	46·1
Atopic eczema	2	3	19–29	22·2
Dermatitis artefacta	1	4	16–49	31·8
Dyshydrosis	10	3	28–52	40·6
Neurodermatitis	12	7	24–63	39·6

TABLE 2.—RESULTS OF ANALYSIS OF VARIANCE FOR EACH RORSCHACH VARIATE*

	H	*P*
M	18·79	<0·02
εC	12·81	—
F%	10·37	—
Anatomy responses	8·91	—
Signs of hysteria	15·06	<0·10
Hostility	20·24	<0·01
Social adjustment	7·42	—
Signs of neurosis	10·59	—
Personal adjustment	7·75	—
Tension	26·02	<0·01
Anxiety	12·05	—

* Excluding the anxiety neurotics.

TABLE 3.—RORSCHACH RESULTS: INDICES SHOWING SIGNIFICANT DIFFERENCES BETWEEN GROUPS

	M		Hostility		Tension	
	Mean	Mean rank	Mean	Mean rank	Mean	Mean rank
Rosacea	0·35	31·2	1·9	36·0	+1·6	51·3
Urticaria	1·6	57·4	4·4	64·6	+2·7	53·0
Seborrhoeic dermatitis	1·1	49·9	4·2	60·7	+2·3	56·6
Pruritis ani	1·7	62·2	5·7	71·6	+3·1	66·7
Pruritis	1·0	37·7	4·8	52·3	+4·4	70·6
Atopic eczema	1·6	59·5	2·4	40·9	+2·1	50·4
Dermatitis artefacta	2·4	62·6	1·6	31·0	+1·0	40·9
Dyshydrosis	1·6	59·4	2·8	45·5	−0·5	20·7
Neurodermatitis	0·8	40·6	2·3	39·2	+1·2	39·7
Anxiety states (female)	1·4	—	1·9	—	+3·2	—
Anxiety states (male)	1·2	—	2·9	—	+2·8	—

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(ii) *Problem* (2)

In view of the uncertain validity of the Rorschach indices and because of the small size of the samples, what follows in the remainder of this paper is tentative and unproven.

Human-movement responses *M* are said to represent the rich inner life of the individual, the inner promptings which control the emotions and lead to a secure, poised, mature attitude to life. They may be said to indicate the degree of maturity of the personality. In terms of this interpretation, rosacea, pruritis, and neurodermatitis are associated with personality immaturity as those conditions showing an impoverishment of *M* responses. It is noteworthy that five pruritis patients exhibited a complete

TABLE 4.—RORSCHACH RESULTS: OTHER INDICES

	Hysteria Mean	*m* Mean	*FC* Mean	*CF* Mean	*C* Mean	Percentage with *F*% 65 or more
Rosacea	1·7	0·4	0·7	1·1	0·0	52·9
Urticaria	3·3	1·1	1·2	1·9	0·8	33·0
Seborrhoeic dermatitis	2·0	0·9	0·2	1·7	0·2	40·0
Pruritis ani	2·8	0·9	0·8	1·4	0·7	33·0
Pruritis	4·0	1·4	0·9	1·2	1·4	12·5
Atopic eczema	2·0	0·2	1·0	0·8	0·4	40·0
Dermatitis artefacta	1·0	0·2	1·2	0·8	0·0	40·0
Dyshydrosis	2·3	1·0	0·5	1·2	0·2	38·5
Neurodermatitis	2·0	0·3	0·3	0·9	0·2	52·6
Anxiety states (female)	2·4	0·7	0·9	0·9	0·8	43·2
Anxiety states (male)	2·8	1·0	0·7	1·7	0·7	39·7

absence of *M* responses. Conversely, dermatitis artefacta, pruritis ani, atopic eczema, dyshydrosis, and urticaria, appeared to occur in a more mature personality setting.

Other reputed indicators of personality immaturity such as the formula $CF > FC$, and the incidence of animal responses *A*%, largely tended to support the finding of rosacea as a consistently immature group, and atopic eczema and dermatitis artefacta as exhibiting the most mature records.

A second statistically significant variate was the hostility score. This score is built up from the number of space responses and the verbal-aggression and hostility-content scores (MONS, 1947). It is usually considered as representing repressed rather than overt hostility. On the basis of this score, pruritis ani was the group which revealed most hostility, closely followed by urticaria, seborrhoeic dermatitis, and pruritis. The inanimate movement responses *m*, which are also often taken to indicate repressed hostility, reached a higher incidence in these groups than in any other except dyshydrosis and the male neurotic group (Table 4).

Where the *m* responses exceed *M* or *FM*, considerable internal conflict is said to exist. This phenomenon was marked only in pruritis. These findings might suggest repressed hostility as a potent source of internal conflict in pruritis.

The tension score,* which also showed a statistically significant variation between the groups, was evolved by PHILLIPS and ELMADJIAN (1947) as an indication of the intensity of the affective drive and the degree of its toleration by the individual. Pruritis ani and pruritis presented the highest mean rank tension scores, indicative of a fairly normal direction and utilization of affective drive and capacity to tolerate tension. A markedly low tension score, suggesting a very poor ability to tolerate tension, was found in dyshydrosis.

The other factors which were statistically compared showed no significant differences, though variations in the signs of hysteria approached significance. This latter factor was scored as per Hertz's classical formula as described by MONS (1947). The maximum score is 6, and a score of 4 or more is taken as pathological. The incidence of such a score was found in 75 per cent of pruritis patients and in 55 per cent of the urticaria group. This contrasted strongly with a maximum incidence of 33 per cent in any other skin group and of 36 per cent in the male control group. The mean rank values confirmed this high incidence in pruritis and urticaria. The interpretation of a pathological hysteria score is debatable, but it is believed to occur most frequently in the hysterical personality rather than in a true conversion hysteria.

The differences between the groups in their use of colour and the reactions to cards 8, 9, and 10, while not statistically significant, showed a general trend in the direction of emotional instability. The *FC* responses were few, and the $FC : CF + C$ ratio unbalanced towards such instability. This trend was most strongly marked in pruritis. Pruritis also appeared to be the most extratensive group, as indicated in the $F\%$ factor, whilst rosacea and neurodermatitis were the most constricted. An arbitrary value of 65 per cent was taken as the dividing line between constriction and dilatation of the personality. The incidence of patients with an $F\%$ of 65 or greater was 12·5 per cent in pruritis as compared with 52·9 per cent in rosacea and 52·6 per cent in neurodermatitis (Table 4). These three groups, with seborrhoeic dermatitis, exhibited the highest scores in the "signs of neuroticism" (HARROWER-ERICKSON), and the poorest personal and social adjustment as scored according to MUENCH. Anxiety indicators were distributed fairly equally through the groups, but tended to be lowest in pruritis ani.

On the basis of these findings it appears that the Rorschach records of the dermatoses tend to fall into two groups; those tending to consistent abnormality, and those closely approaching the normal pattern of response as depicted by KLOPFER and KELLY. Rosacea, seborrhoeic dermatitis, neurodermatitis, and pruritis showed the most abnormal records; atopic eczema and dermatitis artefacta gave the most normal patterns of response. Of the first group, the most consistent abnormalities were exhibited by the rosacea patients. The predominant trends in their records were to an immature reaction to life with a rather infantile but strongly inhibited affective response. All adjustments seemed poor, and neurotic trends marked. The hostility features were relatively low; whereas in seborrhoeic dermatitis, where the records closely resembled those of rosacea, hostility was a prominent feature. Otherwise seborrhoeic dermatitis differed from rosacea only by the evidence of a lesser degree of immaturity and general maladjustment and the indications of an affective reaction of a more primitive impulsive type. Not every record in these two conditions exhibited

* Tension score is derived from drive colour score plus the rejections, minus the perseveration score. Drive colour score = weighted colour responses.

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all these abnormalities, but the overall trend was strikingly consistent in the directions described above. In neurodermatitis, the general trend was in the same direction as in rosacea and seborrhoeic dermatitis, with an immature constricted pattern of response with an inhibited affective reaction tending to the infantile and impulsive. However, this pattern was displayed with much less consistency than in the two preceding groups, and many protocols were of a fairly normal type with others showing various minor degrees of abnormality. Again a consistency of pattern was revealed in pruritis, in the direction of personality immaturity and an undisciplined emotional life not strongly influenced by the environment. These records were distinguished by the absence of *M* responses from five protocols, and the presence of an abnormally large number of pure *C* responses, suggestive of marked emotional instability. The records were dilated with *F*% very low, and the experience balance was considerably extratensive. Neurotic trends were marked, as also were the indications of hysteria. Social adjustment appeared poor.

The tendency in the other dermatoses was to a more normal pattern of reaction, particularly so in the case of atopic eczema and dermatitis artefacta. Apart from the indication of strong obsessional trends and an ambivalent, somewhat constricted experience balance, the records in atopic eczema could be regarded as normal ones. Hostility was little in evidence in this group. In dermatitis artefacta the records were similar, except for a greater tendency to constriction and a somewhat better level of social and personal adjustment. In dyshydrosis, the tension score revealed a most pronounced abnormality. Apart from this and a moderate indication of hostility, the records revealed only a minor trend to immaturity of personality and a somewhat unstable, undisciplined emotional response. Pruritis ani and urticaria also revealed records of similar type, but hostility reactions were very prominent in the first-named condition and to a lesser degree in urticaria. Obsessional trends were also unusually prominent in pruritis ani. Evidence of hypochondriasis was not observed in this condition. Urticaria was one of the few conditions where the records tended to dilatation and extratensiveness. A tendency to neurotic reactions and hysteria was also present.

To sum up these findings, the Rorschach records tended to display a continuum of response extending from marked abnormality to a relative normality. Only rosacea, seborrhoeic dermatitis, and pruritis showed a consistent tendency to congregate at the abnormal end of the scale, and atopic eczema and dermatitis artefacta to appear at the other end. The neurotic control group showed no consistent tendency to abnormality.

4. DISCUSSION

The personality pattern as delineated by the Rorschach in certain groups closely approximated to that elucidated by clinical observation. An independent clinical assessment of a larger number of cases had indicated the consistent tendency of rosacea* patients to present a history of lifelong social maladjustment and to exhibit a marked emotional inhibition. Their personalities might be described as immature in that they were shy, inadequate individuals, markedly lacking in basic self-confidence, and inclined to dependency on their relatives or a few close friends. They all blushed

* The neurodermatoses *clinically* studied in this work were a highly selected group. The clinical findings must be considered as referring only to this group and not necessarily relevant to the neurodermatoses in general.

readily and felt ill at ease in the social setting, although a number endeavoured to compensate for their deficiencies by taking part in community activities. More consistently than any other group of skin cases, they displayed a rigidly controlled emotional life and an inability to easily establish rapport with their fellows. These clinical findings closely correspond to the personality pattern depicted in the Rorschach, with its indications of immaturity and emotional constraint. Clinically, seborrhoeic dermatitis patients closely resembled those with rosacea. They differed in showing better social adjustment and a somewhat hostile paranoid attitude to life. Many of them were bitter, resentful individuals, although others appeared completely normal in this respect. They were not as strikingly constrained as the rosacea patients, but rather often gave the impression of deep brooding tension. This again appears closely related to their Rorschach patterns. Among the other dermatoses, pruritis appeared as a clinically distinguishable group in which hysterical features were unusually prominent. Similarly, an anxious or normal personality with severe prolonged tension was encountered in dyshydrosis and a similar personality often showing considerable overt hostility was met with in pruritis ani. Again the Rorschach patterns for each group were generally in accord. Hostility where marked clinically was usually also prominent in the Rorschach protocols of the relevant groups, as in urticaria. In a number of conditions, such as neurodermatitis, no consistent personality trends could be detected from clinical observation.

The findings for the personality pattern in rosacea obtained in this work accord fairly closely with that depicted in the literature. PLESCH (1951) described his group of rosacea and erythrophobia patients as revealing in their Rorschach patterns "a poorly developed or faulty ego structure and a controlled impulse life." The classical investigation of rosacea of KLABER and WITTKOWER (1939) also stresses, as the prominent personality features, the poor social adjustment and emotional constraint of these patients. PLESCH also suggested a close association between rosacea and neurosis, as 78 per cent of his group exhibited a significant "neurosis score" in their Rorschach protocols. In the series reported here, the incidence of a significant "neurosis score" of 5 or more was 82 per cent in the rosacea group and respectively 66 per cent and 73 per cent in the male and female control groups. The findings in the rosacea group were almost identical with that obtained by HARROWER-ERICKSON for a group of established neurotics.

The close similarity between the Rorschach patterns obtained in seborrhoeic dermatitis and rosacea are of interest, as these conditions are often associated, and both are probably related to an abnormality of the local blood circulation. As the personality types most commonly found in these conditions often exhibit signs of vasomotor instability such as a labile blush reaction, this may possibly explain the close similarity of the personality structure in the two groups. WITTKOWER (1948) stressed the close personality relationship between rosacea and seborrhoeic dermatitis, social inadequacy and anxiety being common to both. He suggested that one differentiating factor was the presence of repressed hostility to a parent figure in seborrhoeic dermatitis. Certainly in this present series a distinguishing feature of seborrhoeic dermatitis from rosacea was the greater evidence of hostility in the former, both clinically and in the Rorschach.

Hostility feelings were prominently displayed in a number of the groups examined in this series. It is often opined by those psychodynamically orientated that the

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neurodermatoses are the expression of such, usually repressed, hostile tendencies. This is a particularly favoured hypothesis to explain the scratching dermatoses. In this series, hostility was not confined to such dermatoses, as it was prominent in urticaria and relatively insignificant in a scratching dermatosis such as atopic eczema and an irritant skin condition like dyshydrosis. This non-sectarian distribution of hostility trends suggests that, if they have any etiological importance in the neurodermatoses, it is as a non-specific source of stress and not confined to the "itch and scratch" dermatoses. However, the association of hostile and hysterical trends in pruritis gives some support for a theory of this condition as a conversion mechanism for repressed hostility.

It is possible that the sex distribution might contribute to the observed differences in the groups for the signs of hostility. From Tables 3 and 4 it is seen that the male control group exhibits a higher incidence of "*m*" and "hostility" reactions than the female group. However, as these signs are also prominent in skin groups with no male predominance and low in other predominantly male groups, it is unlikely the sex distribution has a significant effect on the incidence of such reactions.

The hysterical trends in pruritis were striking, especially in those cases with associated pruritis vulvae. The Rorschach findings would therefore tend to support the long-accepted clinical view of pruritis vulvae as a hysterical conversion phenomenon. The clinical findings suggested that this condition was in many cases a hysterical defence against a disturbing sexual situation. The prominent hostility features in pruritis ani would also accord with a popular clinical hypothesis for this condition.

The Rorschach findings in dermatitis artefacta and atopic eczema tended to run counter to the observed clinical findings in these groups and to those generally described in the literature. Clinically, many of the atopic patients were immature, dependent individuals, often displaying hostile attitudes to one or both parents. They tended to appear moderately self-assertive and driving, but with a persistent conflict between such trends and their basic insecurity and dependency needs. None of this was displayed in their Rorschach records. Hostility was conspicuously lacking in such records, suggesting that this factor may be less important in the etiology of this condition than is usually theorized. Similarly, the Rorschach records in dermatitis artefacta were reasonably normal ones, and displayed little evidence of the hysterical trends usually associated with this condition. Again hostility was inconspicuous.

The reason for such divergence is not obvious. One possible explanation may be that the Rorschach test measures the constitutional elements of personality rather than later acquired tendencies or dispositions. This theory could explain the relatively normal Rorschach patterns in atopic eczema. Overprotected in childhood, the atopic with a personality endowment towards a good adjustment is yet compelled towards insecurity and dependency by the parental attitudes. Such acquired patterns of reaction, and the resentment to the parents inspired by them, would not appear in the Rorschach, as they were not part of the fundamental personality structure. This explanation would also make more understandable why the patient with rosacea, who has also often been overprotected in childhood, yet shows little significant hostility, clinically or in the Rorschach. Endowed with a basically dependent immature personality, he accepts, possibly welcomes, parental overprotection, and remains submissive and dependent.

The Rorschach findings in dermatitis artefacta are difficult to understand in view of the hysterical associations usually credited to this condition. The protocols showed no evidence of hysterical trends. It is possible that conscious rather than unconscious motivations were basic factors in the group of cases studied in this work.

The suggestion is therefore that in those conditions where the Rorschach patterns tend to show a consistent significant abnormality, a constitutional defect of personality exists which may be etiologically related to the neurodermatosis. Environmental factors and current conflicts would appear less relevant to the onset and exacerbations of such conditions than the stress conferred by constant difficulty in personal adjustments. In those cases where the Rorschach pattern was a more normal one, it might be anticipated that the major stresses relevant to the skin conditions would be found in environmental situations leading to neurotic conflicts. In the first group one might include rosacea, seborrhoeic dermatitis, and pruritis; in the second group, conditions such as atopic eczema, dyshydrosis, pruritis ani, and possibly dermatitis artefacta.

However, one must accept that there is no Rorschach pattern which is specific to a particular neurodermatosis. The nature of an unknown case of neurodermatitis could not be diagnosed from the Rorschach findings. One can only state that certain Rorschach patterns tend to appear with more consistency in some skin conditions than in others, and that for this reason the personality structure thereby indicated may be of some importance in the etiology of such conditions.

5. SUMMARY AND CONCLUSIONS

1. A statistical analysis was carried out of certain factors in the Rorschach patterns of ninety-five cases of varied neurodermatoses.
2. The findings of this analysis suggested that certain differences existed in the personality patterns displayed in the differing groups of skin conditions.
3. The significance of such variations was considered and compared with clinical findings in these and other similar cases.
4. A matched control group of ninety-five cases of anxiety neurosis was also investigated for certain Rorschach variables, and the findings compared with those for the neurodermatoses.
5. Certain tentative conclusions were drawn:—
   (a) There was no evidence of a Rorschach pattern specific to any one type of neurodermatosis.
   (b) Certain Rorschach patterns tended to appear with reasonable consistency in particular groups of dermatoses.
   (c) The association of consistent Rorschach patterns with certain neurodermatoses might suggest the differentiation of these conditions into two groups; those with a fundamental personality maladjustment where relevant stresses are incurred from same, and those with an apparently normal personality where the major stresses are environmental and acquired. This, however, should be regarded as a hypothesis for further investigation.
   (d) Sex distribution appeared to have little influence on the differences in Rorschach variables between the groups under investigation.

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(e) The Rorschach findings did not support the view that repressed hostility was of primary etiological importance in the neurodermatoses, or that they represented hysterical conversion phenomena other than possibly in pruritis.

These conclusions are specific for the selected group of neurodermatoses under consideration in this work. In so far as this group is representative of the neurodermatoses encountered in psychiatric practice, the findings may have a wider field of application.

Acknowledgements—We are indebted to Dr. T. J. HENNELLY, Physician Superintendent, Whitchurch Hospital, and to Dr. DEREK RICHTER, Director of the Neuropsychiatric Research Centre, Whitchurch Hospital, for advice and encouragement. Our thanks are due to the Department of Dermatology, Royal Infirmary, Cardiff, for referring patients.

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BOOK REVIEWS

DESMOND O'NEILL, M.D., M.R.C.P.(Lond.), D.P.M.(Eng.) **A Psychosomatic Approach to Medicine.** Pitman Medical Publishing Co., London, 1955. pp. vii + 195. 25s.

THIS is a short and very readable book with the theme that "the sick person needs to be understood by a physician who can take account of his state of mind as well as his bodily disorder." It is primarily intended for the general practitioner and the young hospital clinician.

There are three parts, the first being an extremely good introduction which deals with the evolution of our present doctor-patient relationship and the incidence of stress disorders in practice, and reviews recent experimental work on physical changes in emotional states. The bulk of the book consists of descriptions of a number of symptoms which often appear as a response to stress: these descriptions are illustrated by numerous case histories which, whilst appropriate to the text, are inclined to make for heavy going in certain parts. The third part consists of a short discussion of the principles of treatment of the stress disorders.

The book should fill a need in showing the young doctor the importance of the mind in bodily symptoms, but it can also be criticised on its over-emphasis of this approach. It tends to give the impression that the majority of symptoms encountered in practice are "psychosomatic," and there is very little mention of organic disorders in differential diagnosis. The importance of the philosophy of "holism" should be remembered, and each patient should, indeed, be treated as an individual with his own "loves and hates, hopes and fears," and psychological factors must be appreciated as being possible causes of the presenting symptoms; but at the same time we must try to keep a proper sense of balance and perspective and to appreciate the importance of the "somatic" approach. We must beware of the real dangers of applying too easily the label of "neurosis" to our patients. These difficulties and dangers are particularly applicable to the field of general practice, where lack of time leads to an increase in the speed of work and may cause the patient to be labelled as a "neurotic" as a line of least resistance, and where familiarity with our patients may truly breed contempt, and a previous history of an emotional upset may influence the practitioner in making an inaccurate diagnosis.

All these points may have been assumed by the author, but it is felt by the reviewer that an already good book would become better still if in subsequent editions some sections were added to deal with the importance of differentiating the main stress symptoms from those of serious organic disease, and to note the clinical features which are of help in making this differential diagnosis.

Dr. O'NEILL and his publishers are to be congratulated in the production of this little book, which can be recommended to general practitioners and indeed to all medical practitioners and senior medical students.

JOHN FRY.

MAX HAMILTON, M.D., D.P.M. **Psychosomatics**. Chapman and Hall Ltd., London, 1955. 225 pp. 21s.

THIS book is the ninth published by Chapman and Hall in a series called "Frontiers of Science" designed for scientists who wish to understand what is happening in subjects other than their own. It consists of two introductory chapters concerned with definitions, general theories, the functions of the endocrine and autonomic nervous systems, and learning and development; at the end is a chapter commenting on the limitations of the various approaches used in the field and on approaches not yet fully explored; and in between are 180 pages of well-organized, critical summaries of most of the important contributions in the field arranged according to the somatic system predominantly affected.

Dr. HAMILTON deals explicitly with the major problems met with in the subject and shows how, on the psychological side, the more the data admit of quantification and statistical analysis, the more questionably related they become to any recognizable phenomena of mental life. His meticulous

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inspection of experimental method keeps him afloat in the sea of vague and contradictory results; and though to go down in flames and glory is the fate of heroes, his laborious attempt to keep swimming is little short of heroic. We are left with a hard-boiled account of a great deal of painstaking work that so far has only succeeded in posing more questions than it has answered.

Who is to benefit from this? Anyone seeking a good résumé of a selection of works on the topic will be well served, but the specialist will find his subject incompletely covered. Most laymen will find themselves bogged down in contradictions which, the author rightly points out, disallow any of the simple hypotheses so far advanced and which laymen might reasonably hope to find. Moreover, most inquisitive visitors from other fields will find themselves misled in their attempts to reach the frontiers of this science.

Though billed by his publishers as being biased only in favour of scientific method, Dr. HAMILTON in fact restricts himself largely to the results of the experimental method, and this leads him to give little account of the contributions from other sources. This is quite in order anywhere but in a guide-book. To discuss menstruation without reference to BENEDEK's book on "The Psychosexual Functions of Women," or gastric function without mention of MARGOLIN's experiences with his subject Helen, is to ignore a lot of careful observations and to do less than justice to parts of the frontier that have already been tentatively explored. That the results of such observations allow no satisfactory formulation as yet is nothing unfamiliar in this field, whether studied experimentally or in some other way.

Likewise, if a visitor is to be guided quickly along the entire frontier, then he should be told more about RUESCH's approach to the problem as one of communication, SPERLING's germinal idea of investigating the relationship between mothers and their sick children, and MEAD's examination of sickness in other cultures. Doubtless Dr. HAMILTON feels that these studies cannot fruitfully be brought under the same critical surveillance as has served him well in the material he has presented in the book; this may be so, but we are left with a poor guide-book.

R. GOSLING.

Recent Developments in Psychosomatic Medicine, edited by E. D. WITTKOWER and R. A. CLEGHORN. London, Pitman & Sons, 1954. 495 pp. 50s. Philadelphia, J. B. Lippincott Co. $10.00.

IN presenting a summary of recent developments in psychosomatic medicine, the editors of this volume have included as contributors many distinguished North American workers representing a wide variety of theoretical and clinical approaches. The book is divided into two, the first part dealing with general aspects and the second part with more specific subjects.

Research in psychosomatic medicine has for long suffered from a lack of direction in its aims, a lack of clarity in its concepts, and a lack of controlled scientific evaluation of its findings. Particularly refreshing and stimulating, therefore, is the searching examination and critical attitude which pervades many of the chapters of the first part of this book. In a valuable discussion of "Basic Concepts of Psychosomatic Medicine," MACLEOD, WITTKOWER, and MARGOLIN stress the value of the "field" approach, and elaborate ideas earlier propounded by HALLIDAY. The latter part of the chapter is devoted to a historical survey of the conceptual position of a variety of workers. This useful exposition, however, begins with FREUD, and would appear more logically placed after the historical review in Chapter 3 by MARGETTS. Here the later developments are seen against the perspective of thought extending back to times of antiquity. KUBIE's thoughtful chapter on the "Problem of Specificity in the Psychosomatic Process" emphasizes the importance of overdetermination and stresses the futility of expecting a simple unitary specificity. The fallacious search for simple causality is again dismissed by STEWART WOLF in his chapter on "Experimental Research." He discusses various methodologies, points out the difficulties of evaluating experimental stress, and insists on the need for careful measurement of the end-organ response. Many of these points are again taken up by MALMO in discussing the use and abuse of combined interview and physiological recording techniques. In a chapter entitled "Research: Experimental and Theoretical," he complains of the confusion surrounding the concept of emotion, blaming reification and dualistic thinking as serious obstacles to progress. Further valuable chapters are contributed by MACLEAN on the importance of the limbic area of the cortex; by KUBIE, who gives a summary of his theory of the symbolic process; and by MARGOLIN, who discusses psychotherapeutic principles.

Whilst the first part of this book contains much food for thought and reflection, the second part provides an abundance of information and clinical data. Seventeen chapters are devoted to psychosomatic aspects of various diseases and dysfunctions of various systems. Included also are useful discussions on psychological factors in venereal disease and disablement. On the whole, a high standard is maintained, marred occasionally by a regression to the level of anecdote and by the replacement of demonstration by allegation.

This book provides a very readable account of the present state of our knowledge in the field of psychosomatic medicine. In addition, it frequently points the way for the future. STEWART WOLF advises us that "It may be well to abandon the search for causes of disease and bodily disorders and instead turn our attention to mechanisms and ways in which they can be controlled—or better, to explore the factors in the person and in his environment which make it likely that the mechanisms of disease will be brought into play." The editors themselves in their preface sound the keynote: "The field has some of the elusiveness and at times some of the unreality of Lewis Carroll's phantasy, despite serious deliberations and the accumulation of an enormous amount of material. It would be well for the future studies in this realm if accurate observations, careful induction, and painstaking validation of hypotheses were maintained as conscious objectives."

BRIAN ACKNER.

CONFERENCES

THE first meeting of European research workers in the field of psychosomatic medicine was held at the Maudsley Hospital, London, England on 22–23 April 1955.

Abstracts of some of the papers presented at this conference will be published in the next issue of this journal.

The Second Conference of research workers in psychomatic medicine will be held in Amsterdam from 17.4.56 to 21.4.56. Details should be obtained from Dr. J. GROEN, Wilhelmina Gasthuis, Amsterdam, The Netherlands.

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Editorial

In this issue we are publishing a group of papers relating to disorders of respiration. Clinical, experimental, and statistical methods have been used. At the same time we have taken the opportunity of introducing a paper from Spain, concerned with a conceptual approach which may not be familiar to English-speaking readers. From time to time we hope to present such contributions in order that workers in various countries may become familiar with the different frames of reference used in the field of psychosomatic medicine.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 98 to 114. Pergamon Press Ltd., London

PHYSICAL AND EMOTIONAL FACTORS IN BRONCHIAL ASTHMA

LINFORD REES, M.D.*

ASTHMA continues to be a subject of medical controversy despite its recognition from ancient times and its present-day prevalence. WILLIAMS (1952) drew attention to the social importance of asthma, reporting that asthma is as common a cause of disability as gastric and duodenal ulcer combined; is commoner than all fractures; than high blood-pressure, angina pectoris, and vascular heart disease together, and that it causes nearly twice the incapacity due to all forms of tuberculosis. Asthma is also responsible for 0·6% of all deaths. Among university students, 33 per 1000 gave a history of asthma, and 17 per 1000 had active asthma. These figures signify the great social importance of asthma, and indicate the need for research into the disorder in all its aspects.

The recognition of emotional factors in the precipitation of asthma goes back to ancient times. HIPPOCRATES advised the asthmatic subject to guard himself against anger. VAN HELMONT (1650) introduced the concept of nervous or spasmodic asthma, and THOMAS WILLIS (1672), in his classical account of the disease, mentioned that emotions could bring on attacks. Sir JOHN FLOYER (1685) appears to be the first to attribute asthma to contraction of the bronchial musculature, which was also later emphasized by CULLEN (1784) and LAENNEC (1835). SALTER (1859), in his monograph on asthma, distinguished cardiac and spasmodic types, and drew attention to the hereditary factor and to the precipitation of attacks by animal emanations. CURSCHMAN (1882) thought asthma to be due to an exudative diathesis, and noted the characteristic spirals, now bearing his name, in the sputum.

In 1910, MELTZER suggested the possible relationship between anaphylaxis and asthma. During the present century the spectacular rise in the knowledge of anaphylaxis and allergy has tended to overshadow the consideration of the psychological aspects of asthma and to throw doubt on the validity of earlier observations on the role of emotional factors in asthma. From time to time, however, papers have appeared indicating the importance of psychological causes in asthma, e.g. SAENGER (1910), REICHMAN (1922), COSTA (1922), MOHR (1925), MOOS (1923, 1928), HANSEN (1927), STRAUSS (1927), SCHULTZ (1928), MAXWELL (1936), and GILLESPIE (1936). The literature on the psychological aspects of asthma has been reviewed by WITTKOWER and PETOW (1931), DUNBAR (1946), ABRAHAMSON (1948), and LEIGH (1953).

Although there is now considerable evidence that emotional factors play a role in the causation of asthma, at least in some patients, there is little agreement on the extent to which such factors occur and the precise role they play. DUNBAR (1946) points out that many studies on psychomatic relationships have been on isolated or selected groups of patients where emotional factors have been obvious. This has led to unwarranted deductions concerning the role of the psychic component of the disease in question, and that often an aetiological relationship is assumed rather than

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demonstrated. It appears that, in the past, psychiatrists have not paid sufficient attention to possible physical factors, and that allergists have not adequately recognized the importance of emotional factors in asthma. Few studies have used control groups, and the need for controlled studies in asthma has recently been strongly stressed (ABRAHAMSON, 1951).

The aim of the present investigation is to study the incidence and relative importance of various possible causative factors in the aetiology of asthma.

METHODS

The group studied consisted of patients attending the Asthma and Allergy Clinics of St. David's Hospital, Cardiff. Each patient was fully investigated from the physical point of view by the consultant physician, and by an ear, nose, and throat specialist. X-rays and laboratory investigation were carried out when indicated. Each patient was also investigated in detail from the allergic aspects including skin testing, and by exposure and exclusion tests with suspected allergens. A detailed psychiatric assessment was carried out by the author without knowing the physical findings in the case. The final aetiological assessment was made by consultation between the allergist in charge of the clinic and the author.

The items relating to each patient were entered on a special item sheet and finally transferred to Hollerith punched cards. Analyses were carried out by means of the Hollerith counter sorter. Only patients with definite asthma in accordance with the following characteristics were included in the study, viz. patients with recurring attacks of dyspnoea and wheezing, with prolongation of the expiratory phase. The diagnosis, therefore, cannot be made on a single attack, and a period of observation may be necessary before a diagnosis is made. Intensive physical investigation may be necessary to exclude other causes of dyspnoea. Cardiac asthma and all secondary causes of wheezing and dyspnoea, such as from enlarged mediastinal glands, retrosternal goitre, etc., were excluded.

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MATERIAL

762 persons were studied, including:

(1) 441 patients attending the asthma and allergy clinics.

(2) 321 subjects studied for control purposes.

The asthma patients represent a random sample of patients attending the clinic. The adult control subjects consisted of random samples of hospital patients who had been operated upon for appendicitis or hernia. The control group of children was obtained from those who had attended the accident unit of the hospital. It may be considered that control subjects obtained from an accident unit may not be as satisfactory as herniotomy or appendicectomy subjects in view of the possibility that emotional factors may have contributed to some accidents. Investigation of the control subjects revealed that emotional factors clearly contributed to the accident in about 8% only of the series. Comparison of such items as family history would not be affected by having accident controls, but should be borne in mind when comparisons are made in personality and neurotic symptoms. The effect of having accident controls would, in fact, enhance the significance of differences in psychological attributes between asthma and control groups rather than invalidate comparison.

AETIOLOGICAL CONCEPTS

Aetiology is concerned with the assessment of predisposing as well as precipitating factors. The precise nature of predisposition to asthma is not fully known. The work of SCHWARTZ (1952) provides strong evidence of an hereditary basis for asthma, but the importance of genetic factors is doubted by some authors (RATNER and SILBERMAN, 1953). In clinical practice, the assessment of the main immediate factors determining the onset and precipitation of attacks during the course of the illness is of particular importance. In this study, it was found that infective, allergic, and psychological factors were the main precipitating causes of attacks. An attempt was made to assess the relative importance of each of these factors in every patient. The assessment was made after discussion between allergist and psychiatrist, taking into account all the clinical and laboratory findings in the case. A factor was assessed as dominant if it accounted for most of the attacks during the illness. Other factors were assessed as subsidiary if there was definite evidence of a precipitating role. The

subsidiary role varied from being an infrequent to a very frequent precipitant of attacks. A factor was assessed as unimportant if there was no evidence that it played any causative role in the particular individual under consideration.

This method has the advantage of being based on a multiple approach, with due regard being paid to possible physical and psychological factors. In a study of the aetiology of asthma it will be necessary to consider various features or attributes of the individual to ascertain whether they are relevant and casual, and what aspects of the individual-environmental interaction may also be casually important. In the individual the following features, among others, will need consideration: age and sex factors, family history, personality, neurosis and predisposition to neurosis, and endocrine influences.

In the person-environmental interaction should be considered the physical aspects of the external environment, infection, allergy, and psychological influences.

AGE AND SEX INCIDENCE

In our group of 441 asthma patients, there were 229 males and 212 females. A comparison of groups under 16 years, and of age-groups of 16 years and over reveals differential sex incidence. Before the age of 16 years there are twice as many boys as girls (138 boys, 65 girls); after the age of 16 there is a preponderance of females (females 147, males 91) (Table 1). This distribution is similar to that described by BRAY (1934). The differential sex incidence in adults is well shown in 16–45 age groups, and still holds, but to a lesser extent, in the age group 46–55 years.

TABLE 1. AGE DISTRIBUTION

Age group (years)	*Males*		*Females*	
	Number	*%*	*Number*	*%*
0–5	38	16	14	66
6–15	93	40	51	24
16–25	11	4·8	31	14·6
26–35	23	10	35	16·2
36–45	26	11	34	16
46–55	16	6	25	11
56–65	22	9	22	10

AGE AT ONSET

From Table 2 it will be seen that 63% of males start having asthma before the age of 16, compared with 50% of females. Between 16 and 46 years a higher percentage of females than males have their onset of asthma (40·5% females and 30·8% males). This differential sex incidence in age at outset in children and in adults is confirmed in a series of 1000 male and 1000 female asthmatics (WILLIAMS, 1952).

FAMILY HISTORY

When comparing data relating to family history in different groups it is essential that the groups must correspond in age distribution and that the extent of the enquiry into the pedigree must be the same. Table 3 gives data on the incidence of asthma and related disorders in parents, and siblings of asthma and control groups, matched for age distribution. All asthmatic groups except males under age 16 years have a statistically significantly higher incidence of asthma, hay fever, vasomotor rhinitis,

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and flexural eczema in parents and siblings. These results support the findings of SCHWARTZ (1952) on the role of heredity in asthma.

TABLE 2. AGE AT ONSET

Age group (years)	*Males (%)*	*Females (%)*
0–5	51·5	32
6–15	12·2	18
16–25	5	15·5
26–35	13·2	16
36–45	12·6	9
46–55	3·5	6·3
56–65	0·5	2·1

TABLE 3

Family history	Under 16 years of age				Over 16 years of age			
	Male		Female		Male		Female	
	Asthma (98)	Control (102)	Asthma (72)	Control (55)	Asthma (100)	Control (54)	Asthma (149)	Control (110)
Incidence of asthma, hay fever, vasomotor rhinitis, and flexural eczema in parents and siblings	% 23	% 14	% 36	% 14	% 39	% 16	% 45	% 11

PERSONALITY

The theory that various psychosomatic disorders are associated with more or less specific personality patterns has occupied an important place in psychosomatic medicine (DUNBAR, 1946; HALLIDAY, 1948). A number of personality traits were rated on a three-point scale in asthmatic and control groups by the author, using identical standards and criteria. The result will be presented in more detail in another communication (REES, 1956b).

Some of the findings are shown in Table 4, from which it will be seen that all asthma groups have a significantly higher incidence of individuals with very anxious personality than control groups. All asthma groups, except adult males, have a significantly higher evidence of individuals who were rated as being very timid, very obsessional, or very sensitive. All asthma groups, except boys, have a significantly higher incidence of individuals rated as being very unstable and ill-adjusted.

The results indicate that asthmatic subjects may show many varieties of personality type, but that, in the group as a whole, there is a significantly higher incidence of certain personality traits, such as marked anxiety, marked timidity, marked sensitiveness, and marked obsessional traits. The importance of these findings lies in

the fact that these traits, in different ways, are conducive to the development of states of emotional tension which in turn may act as precipitants of attacks of asthma.

TABLE 4.—PERSONALITY TRAITS

	Under 16				Over 16			
	Males		Females		Males		Females	
	Asthma	Controls	Asthma	Controls	Asthma	Controls	Asthma	Controls
Number	98	102	72	55	100	54	149	1110
	%	%	%	%	%	%	%	%
Markedly timid and meek	30	7***	48	18***	13	7·4	35	5***
Very sensitive	59	39**	82	27***	39	31	59	32***
Markedly anxious	50	17***	70	10***	43	20***	57	30***
Very meticulous and obsessional	32	12***	39	12·7***	25	27	58	24***
Very unstable and ill-adjusted	4	3	16	0	8	0	12	1·8***

Statistical significance is denoted by asterisks.
* Denotes doubtful significance (critical ratio nearly 2)
** Significance between 0·5% and 0·1% level
*** Markedly significant (critical ratio above 3)

Some authors have suggested a high degree of correlation between cyclothymic personality trends and asthma (REICHMAN, 1922; STOKES and BEERMAN, 1940). However, in our series, definite cyclothymic personality was only found in 3% of the boys and 4% of the girls; in 9% of the women it was found in a well-marked degree, and in 22% in a moderate degree; in 1% of the men it was found in a well-marked form and in 9% in a moderate degree. Thus, we cannot agree that a cyclothymic temperament is the most common personality type found in asthma, but the incidence is, statistically, significantly higher than in the control groups. The group showing cyclothymic trends in greatest frequency was the adult female group, 31% of whom showed moderate and marked cyclothymic trends, compared with 6%, in a moderate degree only, in the control group. A hysterical type of personality was not commonly found among asthma patients; it was present in 6% of the girls and 11% of the women, and in about 3% in male groups, compared with 3% in control groups.

NEUROSIS AND NEUROTIC SYMPTOMATOLOGY IN ASTHMATIC PATIENTS

There has been considerable speculation in the relationship between neurosis and asthma. Many authors have described asthma as a respiratory neurosis. It is commonly suggested that asthma attacks have a hysterical basis, i.e. that the attack is motivated for some real or fancied gain without the patient being fully aware of the motivation. The neurotic and asthmatic populations are so large that there is bound to be some overlap. Thus, the occurrence of neurosis or neurotic symptoms in asthma may be merely coexisting without an aetiological relationship, or the neurotic pattern of reaction may be casually related to attacks of asthma.

Two methods of studying the possible significance of neurosis and neurotic symptoms in asthma are available. The first is the statistical approach in which the incidence of neurosis and neurotic

symptomatology is assessed both in asthma and in normal control groups of the same age and sex distribution by the same methods, standards, and criteria, and preferably by the same investigator. The second is the detailed investigation of each patient in order to ascertain the frequency with which neurotic reactions and emotional factors are concerned with the precipitation of attacks (vide Table 8).

TABLE 5.—INCIDENCE OF NEUROSIS AND NEUROTIC SYMPTOMATOLOGY IN ASTHMA AND CORRESPONDING CONTROL GROUPS

Neurotic symptoms	Under 16				Adults			
	Male		Female		Male		Female	
	Asthma	Controls	Asthma	Controls	Asthma	Controls	Asthma	Controls
Nil	56	91***	65	98***	56	85***	30	80***
Mild and moderate	16	9	39·5	2	42	15	45	20
Marked	28	0	5·5	0	2	0	25	0
Poorly adjusted	49	12***	35	10***	27	10***	45	15***
Anxiety state	8	0	7	0	6	2	18	0
Depressive state	0	0	0	0	2	0	3	0
Hysteria	0	0	0	0	0	0	3	0

*** Markedly significant (critical ratio above 3)

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Reference to Table 5 will show that neurotic symptoms occur in a statistically higher incidence in asthma compared with control groups of similar age and sex distribution. It is interesting to note that neurotic symptoms are more common in males than females under 16 years of age, and more common in women than men over the age of 16 years. A diagnosis of neurosis occurred most frequently in the adult female asthmatic group (24%). The most common form of neurosis was anxiety state. Hysteria was diagnosed in only 3% of the adult female asthmatic group, and none of the other asthmatic groups. A hysterical attitude to the illness and "secondary gain" relating to attacks occurred in higher frequencies, but not more than 15–20% of the groups. Interesting interrelationships between neurotic reaction to stressful life situations and the precipitation of asthma were observed, and will be referred to later.

Our findings conform to those of HORNECK (1940), who found a much higher incidence of neurotic conditions among allergic than among nonallergic persons. URBACH (1946) considers that HORNECK's (1940) findings would seem to justify the assumption that nervous instability constitutes a predisposing factor in relation to asthma and allergic disorders.

ENDOCRINE INFLUENCES

A special study of the tendency for asthma to develop in association with certain phases of the menstrual cycle was carried out in a group of 81 female asthmatics. It was found that 34% of 81 women showed an increased tendency for attacks to occur premenstrually. A comparison of this group with those in whom asthma had no premenstrual association revealed interesting differences in the incidence of various manifestations of the premenstrual tension syndrome. The results of this investigation, together with discussion on pathogenesis and treatment, is described in detail elsewhere (REES, 1956a). A complex interplay was found in these patients between allergic, infective, psychogenic, and endocrine influences.

ENVIRONMENTAL INFLUENCES

Two kinds of environment may be described, the internal environment consisting of the various body fluids and forming the milieu of the body cells and tissues, and the external environment which is defined by KIMBALL YOUNG (1947) as the dynamic forces, situations, and stimuli external to the organism, which influence its development and modify its responses. Many environmental factors may be relevant in the aetiology of asthma.

(1) Place of residence may determine the degree of exposure to specific allergens, e.g. pollen and moulds. Dampness may predispose to infection.

(2) Occupation may have nonspecific precipitating effects, e.g. fumes, dust, changes of temperature, odours etc., or may be associated with specific allergens, e.g. bakery, confectioners, furriers etc.

(3) Seasons—asthma due to pollen allergy will tend to be prevalent in the pollinating season, and asthma due to moulds will tend to occur at the times airborne moulds are prevalent. Infective asthma tends to be worse in winter.

PERSON-ENVIRONMENT INTERACTION

Environmental influences cannot be considered in isolation, and their importance is always determined by the person-environment interaction. In the formulation of KURT LEWIN (1936), we may say that behaviour B is a function F of the person P and of his environent E.

$$B = F(PE)$$

The state of the person P and that of his environment E are not independent of each other. P and E have to be regarded as variables which are mutually dependent on each other. The totality of such coexisting mutually interdependent factors is called a field (EINSTEIN, 1933). The aetiological field in asthma is complex. Three very important parts of this field may now be considered.

(1) Allergy.

(2) Infection.

(3) Psychological influences.

THE ALLERGIC FACTOR

The term allergy was first used by VON PIRQUET in 1906 to designate an alteration of reaction during a second or subsequent injection of smallpox vaccine and of horse-serum. The prerequisites for the allergic state are:

(1) An increased sensitivity of the cells involved to one or more allergens.

(2) The presence of allergen or allergens in the immediate cell environment or within the cell membrane in sufficient concentration to disturb function.

A third factor is the autonomic nervous-system control of cellular and organ function, the significance of which will be considered later.

An allergic basis for asthma was postulated by MELTZER (1910), and the allergic aspects of asthma have dominated medical opinion to date. The allergic aspect of asthma has been investigated in detail in our patients by history and clinical examinations, by skin testing, and by clinical trials consisting of exposure and exclusion tests with suspected allergens. In allergic reactions it has long been recognized that the patient does not always react in the same degree to a given exposure of allergen. Sometimes the patient shows increased sensitivity, and at other times decreased sensitivity, to the same dose of allergen.

THE INFECTIVE FACTOR

The present investigation has indicated the importance of the infective factor in the aetiology of asthma. Acute, subacute, chronic, or focal infections may either initiate the first attack, or induce an attack in a person suffering from asthma, or prolong an existing attack. Acute infections involving the upper or lower respiratory tract may precipitate the first attack of asthma. This is an important cause of primary attacks in childhood and in late middle life. The most common precipitant is acute bronchitis. In children the onset commonly follows whooping cough or pneumonia. Our investigation shows that infective factors may precipitate attacks of asthma in patients whose asthma is predominantly allergic or predominantly psychological in origin, and that there is an intricate interplay between infective, allergic, and psychological influences.

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ASSESSMENT OF RELATIVE IMPORTANCE OF AETIOLOGICAL FACTORS IN VARIOUS AGE AND SEX GROUPS

Table 6 gives the aetiological assessment, as agreed by allergist and psychiatrist, in various age groups in each sex. It can be seen that females show a higher incidence of psychological factors than male patients in all age groups from 16–65 years. In children, the incidence of psychological factors is roughly similar in boys and girls.

TABLE 6.—AGE AND SEX GROUPS

Aetiological assessment	0–5 yr.		6–16 yr.		16–25 yr.		26–35 yr.		36–45 yr.		46–55 yr.		56–65 yr.	
	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)
Psychological factors														
Unimportant	39	37·5	24	27	59	22	65	20	38	11	56	0	18	10
Subsidiary	36·5	50	46	41	33	55	30	48	42	53	37	56	54	50
Dominant	23·6	12·5	30	31	8	22	4	31	19	35	6	44	27	40
Infective factors														
Unimportant	15	7	31	27	63	39	43	40	42	44	25	48	50	41
Subsidiary	34	35	27	27	18	39	35	63	11	35	31	48	18	41
Dominant	50	57	42	45	18	22	21	26	46	20	43	4	31	18
Allergic factors														
Unimportant	63	64	66	70	45	29	47	43	73	44	62	60	72	72
Subsidiary	22	38	38	17	0	39	6	34	4	42	26	20	10	9
Dominant	15	14	16	13	54	32	47	23	23	4	12	20	18	9

In females the incidence of psychological factors increases with age. In males there is a decrease in the period 16 to 35, with a later increase in the age group 56 to 65. Incidence of infective factors is roughly similar in boys and girls before puberty and shows no striking variation for adults, apart from the low incidence in the 16–25-year male group. Allergic factors are roughly similarly distributed in the age and sex groups before 16. After 16 there is a marked increase of allergy as the dominant factor in males in the 16–35-year age group, with the incidence of allergic factors declining in older male asthmatic groups. In females, allergic factors are higher in the age groups from 16–45 years than earlier or later in life. Taking the group as a whole, we have the following distribution of aetiological factors.

	Dominant (%)	*Subsidiary* (%)	*Unimportant* (%)
Psychological	37	33	30
Infective	38	30	32
Allergic	23	13	64

Thus, psychological factors are aetiologically important in 70%, infective factors in 68%, and allergic factors in 36%. More than one aetiological factor is usually

present in a large proportion of asthmatics, and in some all three factors may be present.

The percentage distribution of the incidence and combinations of various aetiological factors is given in Table 7.

TABLE 7.—PERCENTAGE DISTRIBUTION AND COMBINATIONS OF AETIOLOGICAL FACTORS

	%
Psychological factors dominant with infective factors as sole subsidiary agent	13
Psychological factors dominant with allergic factors as sole subsidiary agent	3
Psychological factors dominant with both allergic and infective factors subsidiary	3
Psychological factors dominant, infective, and allergic factors unimportant	18
Infective factors dominant with psychological factors as sole subsidiary agent	14
Infective factors dominant with allergic factors as sole subsidiary agent	3
Infective factors dominant with both allergic and psychological factors subsidiary	4
Infective factors dominant with allergic and infective factors unimportant	17
Allergic factors dominant with psychological factors as sole subsidiary agent	5
Allergic factors dominant with infective factors as sole subsidiary agent	4
Allergic factors dominant with both psychological and infective factors subsidiary	10
Allergic factors dominant with psychological and infective factors unimportant	4

MAIN AETIOLOGICAL FACTORS AT THE ONSET OF ASTHMA

What are the factors responsible for the initial attack? In children, infective factors determine the onset in 55%, and in adults 45%; allergic factors in about 20% of children and adults; and psychological factors in 25% children and about 35% of adults. In some patients, the onset appears to be determined by a combination of either allergy or infection with emotional tension. The main cause at the onset does not necessarily remain the dominant aetiological factor throughout the course of the illness. All varieties of sequences and combinations of allergic, infective, and psychological factors were found in the group.

PSYCHOLOGICAL FACTORS

The influence of psychological factors in asthma is strikingly demonstrated by the immediate precipitation of asthmatic attacks by emotional changes. Data on the emotional precipitation of attacks of asthma in various age and sex groups are given in Table 8. These refer only to attacks in which emotional precipitation was clearly demonstrated. This must, therefore, be regarded as a minimal figure, as observation of each patient over an unlimited period would undoubtedly increase the incidence of demonstrable psychogenic precipitation of attacks.

From Table 8 it will be observed that in males there is a lower incidence of emotional precipitating factors in the age range 16–35, and a rise again after 35. In females, the incidence increases as we proceed from the younger to the older age groups, rising to 84% in the age group 46–65.

The investigations indicated that a large variety of emotions may serve as precipitants of an asthma attack. The following are the commoner precipitants: Anxiety with tension; Anticipatory pleasurable excitement; Tension due to frustation of any need; Anger; Resentment; Humiliation; Depression; Laughter; Guilt feelings; Joy and elation.

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TABLE 8.—EMOTIONAL PRECIPITATION OF ASTHMA

Age groups	0–5 yr. M. (%)	0–5 yr. F. (%)	6–15 yr. M. (%)	6–15 yr. F. (%)	16–25 yr. M. (%)	16–25 yr. F. (%)	26–35 yr. M. (%)	26–35 yr. F. (%)	36–45 yr. M. (%)	36–45 yr. F. (%)	46–65 yr. M. (%)	46–65 yr. F. (%)
Not precipitating	40	46	36	36	70	26	70	28	31	15	32	2
Doubtfully precipitating	7	0	5	5	15	13	19	9	15	13	19	9
Definitely precipitating	53	46	57	57	20	55	26	69	31	74	54	84

Even more important than the type of emotion was the suppression, or inadequate expression, of emotions. Many asthmatic patients tend to "bottle up" their feelings, giving rise to mounting or prolonged states of tension, which are conducive to the precipitation of attacks of asthma. Sudden emotional changes, as well as prolonged states of emotional tension, will predispose, precipitate, prolong, or aggravate attacks of asthma.

LIFE SITUATIONS ASSOCIATED WITH PRECIPITATION OF ASTHMA

It has been observed that emotional changes act as precipitants of asthma in all age groups. Emotional changes are intimately dependent on both personality factors and environmental influences. Certain life situations tend to evoke emotional changes which in turn precipitate attacks of asthma. In the patients included in the present study a large variety of different life situations and associated emotional reactions were found to be associated with the precipitation of asthma attacks.

Aetiologically the importance of a particular life situation of an asthmatic will be determined not only by the degree of stress inherent in the situation, but by the patient's susceptibility and reaction to such stress. In practice, the concept of stress is only helpful if considered in relation to the patient's response to it, as stresses associated with various potentially traumatic events are not equally stressful to all persons, or even to the same person at different times. Furthermore, the situations which may be aetiologically important in asthma differ according to the life period of the patient. For example, in infancy and childhood, parental attitudes are of paramount importance; in later childhood a variety of stressful situations, ranging from frightening experiences to adjustment problems at school, may be important. In elderly patients, the aetiologically important life situations are often related to problems of adjustment to the changed constitutional status and environmental relationships in old age (REES, 1956e).

The great variety of life situations found to be related to the precipitation of asthmatic attacks in our group does not lend itself readily to classification. In some patients, the onset of asthma, or precipitation of asthmatic attacks, is related to sudden severe emotional stress, such as death, injury, or illness of loved persons, or to other crises. In others, prolonged stress associated with a variety of situations such as those involving problems in work, finance, family, love affairs, or marriage, may be of relevance. The importance of a particular life situation in the etiology of asthma will depend on a number of factors in addition to the intensity and duration of stress of the situation. Individual factors, such as constitutional predisposition, personality attributes, general stability, and adjustment, will influence the patient's resistance and vulnerability to stressful situations. The individual's reaction may also be influenced by the cumulative effect of previous stresses, and by a specific vulnerability to certain situations. The tendency for an attack of asthma to be precipitated in a particular subject will be influenced by the intensity and quality of emotional reaction evoked and the extent to which such emotions are suppressed or inadequately expressed.

No evidence has been found in this study of specificity of life situations associated with the development of asthma. Any situation or stimulus, if it evokes the necessary degree of emotional reaction, may precipitate asthma in the affected subjects.

EMOTIONAL FACTORS IN CHILDHOOD

Table 8 shows that psychological factors were found to play an aetiological role in from 61% to 76% in asthmatic children. Parental influences were important in determining emotional reactions precipitating attacks of asthma in children. Certain faulty parental attitudes were conducive to the precipitation of asthma in a child, the most common being over-protection. This was found in significantly higher incidence in the asthmatic than control groups. Other faulty parental attitudes such as rejection and perfectionism also occurred, but less frequently than over-protection. It has been suggested that faulty parental attitudes are a result rather than a possible cause in asthma. In a detailed analysis of the determinants of parental attitudes in asthmatic children, it was found that in a high proportion of such cases the faulty attitudes antedated the onset of asthma, and were due to a number of other factors. Parental guidance was found to be one of the most effective therapeutic methods in treating asthmatic children (REES, 1956c).

ARE PSYCHOLOGICAL ATTRIBUTES IN ASTHMA PATIENTS AN EFFECT RATHER THAN A POSSIBLE CAUSE?

Some allergists maintain that emotional disturbances, personality traits, and associated psychiatric symptons in asthma are a result rather than a possible cause of asthma. Asthma is a frightening occurrence for the patient, his family and friends, and the disability it may cause can greatly affect the patient's life. Psychological factors, it has been said, only occur in long-standing cases. In the present study this possibility has been investigated in two ways. Firstly, in a large number of patients the psychological attributes of the patient were found to antedate the onset of asthma. Secondly, by means of the Hollerith sorting machines, the incidence of various psychological attributes in patients of varying duration of illness has been compared. Various psychological attributes which have been described as relevant and causal were found in a substantial proportion of patients examined soon after the onset of the illness, and could not be attributed to the duration of illness (REES, 1956d).

INTER-RELATIONSHIPS OF CAUSATIVE FACTORS

The findings of this investigation into the aetiology of asthma indicate that in the majority of patients a multiplicity of causal factors is the rule. The causes at the onset may not always operate to the same extent or frequency during various phases of the illness. Thus, a child may develop asthma due to infection, and later develop sensitivity to various allergens which may themselves give rise to some attacks; other attacks may be precipitated by emotional tension. In women, endocrine changes may also cause some attacks. The onset of asthma may be determined by allergic causes, and later infective or psychological factors may be dominant or subsidiary in aetiology. In fact, we find all kinds of sequences and combinations of causative factors. In a small proportion, patients may remain predominantly allergic, psychogenic, infective, or endocrinological in the causation of asthma, but in general more than one causative factor is in operation. It is well known that the response to an allergen in a given patient is not always quantitatively constant. Sometimes marked reactions occur, and at other times similar exposure does not produce any reaction. Clinical observation suggests that allergic responses are intensified by emotional tension, and studies by HOLMES *et al.* (1951) have given experimental validation to these

observations. Similarly, respiratory infection may intensify or prolong allergic asthmatic attacks. Clinical observations also suggest that emotional tension may be conducive to the development of infections of the respiratory tract. In women, the changes occurring during the premenstrual period involving hydration of the bronchial and other tissues will also influence the response of the bronchial mucous membrane to allergic, psychogenic, and infective influences. The observations reported here indicate that allergic, infective, endocrinological, and psychological factors may be additive, and even synergic in the causation of asthma. A possible physiological basis for such interrelations will be considered when dealing with the autonomic nervous system.

THE ROLE OF THE AUTONOMIC NERVOUS SYSTEM

Recent research has indicated that the autonomic nervous system may play an important role in asthma and in related disorders such as vasomotor rhinitis and hay-fever. The efferent innervation of the respiratory tract, including nasal mucosa, larynx, trachea, bronchi, and bronchioles, comprises both sympathetic and parasympathetic nerves (KUNTZ, 1951). The smooth muscle of the respiratory tract is innervated by both sympathetic and parasympathetic fibres. The glands in the mucous membranes are innervated directly only through the parasympathetic. The parasympathetic nerves exert a tonic restrictor influence on the smooth muscles of the respiratory tract; the sympathetic have an inhibitory influence. The bronchial musculature is controlled by reflexes, e.g. irritation of tracheal or bronchial mucosa produces reactions in bronchial musculature which tend to prevent displacement of matter in the respiratory tract downwards (KUNTZ, 1951). The effect of vagal action on the bronchi is to cause contraction of the bronchial muscle with decrease in size of the lumen, and also increased secretion and swelling of the bronchial mucous membrane.

FOWLER (1950) has shown that parasympathetic overactivity produces a pale thickened nasal mucous membrane with watery secretion. These changes are typical of vasomotor rhinitis. HOLMES *et. al.* (1950) find that interruption of the sympathetic nerve supply to the nose is followed by hyperaemia and swelling of the nasal mucosa, together with hypersecretion. Similar changes occurred with emotional conflicts, and with feelings of humiliation, frustration, and resentment. They also found that evacuation, by ciliary action, of surface organisms is impaired when mucous membrames are swollen and hypersecretive, and that the associated lymph stasis increased the vulnerability of the tissues, thus offering ideal circumstances for the establishment of infection. They were able to correlate narrowing of the nasal passages in response to threatening stimuli with narrowing of the bronchi. Thus emotional tension stimulating increased parasympathetic activity can cause the specific nasal changes found in vasomoter rhinitis and the bronchial changes found in asthma. Further interesting experiments have been carried out by HOLMES, TREUTING, and WOLFF (1951) on the reaction of the nasal mucous membrane to standardized doses of pollen. It was found that the intensity of response varied with the condition of the nasal mucosa. Existing infection would intensify the response, as would states of emotional tension due to feelings of humiliation, resentment, or frustation.

The majority of the changes found in "shock tissues" in response to allergens can be reproduced by histamine and acetylcholine (JAROS, 1951). Acetylcholine is released at parasympathetic nerve endings, and at all autonomic ganglia. Increased liberation of acetylcholine will occur during parasympathetic overactivity due to emotional tension. Histamine has also been shown to be liberated by emotional stress (CANNON, 1928). Histamine, as well as acetylcholine, is parasympathomimetic. Small amounts of histamine and acetylcholine will precipitate asthma. Recently it has been demonstrated that acetylcholine will intensify allergic tissue reactions. Vagal stimulation itself will produce asthma (BRAY, 1934).

The immediate precipitation of an asthma attack by emotional tension could be adequately accounted for by parasympathetic activity. The autonomic nervous system can also influence asthma in other ways:

1. The work of HOLMES *et. al.* (1950) suggests that the tissue changes produced by parasympathetic actions are conducive to infection.

2. The intensity of the allergic tissue response can be influenced by acetylcholine liberated by parasympathetic activity resulting from emotional tension.

3. Parasympathetic activity and acetylcholine can modify enzyme activity and cellular permeability. Enzyme systems are responsible for the formation and destruction of histamine and acetylcholide. Altered cell permeability will influence the distribution of histaminase and allergens.

4. The parasympathetic (and therefore emotional) tension can also effect the vascularity of tissues, and in this way modify the intensity of tissue responses to various stimuli.

5. Autonomic activity greatly influences the functions of the alimentary canal and can influence the degree of absorption of allergens.

The evidence available indicates that the autonomic nervous system probably plays an important role in the complex interplay of causative factors in asthma and provides a physiological explanation for the clinically observed interrelationships between allergic, psychogenic, infective, and endocrine processes.

SYNTHESIS AND FORMULATION

These investigations show that asthma is usually a disorder of multiple causation. The current practice of diagnosing a case as either allergic, or infective, or psychogenic, or due to other single cause, is inadequate. It is more appropriate to consider and assess all the causative factors in the particular case, so that an aetiological diagnosis would be a composite assessment. Ideally, if it were possible, the relevant and causal aspects of the organism-environment interaction should also be included in the aetiological diagnosis. These factors can be of paramount importance. It has been observed that tensions arising in patients as a reaction to certain life situations may well be a dominant factor in aetiology. Similarly, parental influences may be powerful factors in the causation of asthma in children. Unfortunately, there is not, as yet, any satisfactory simple method of including these important causative forces in an aetiological diagnosis.

The aetiology of asthma may be considered as a field in which a large number of interdependent causative factors, both in the organism, and in the environment, exist and interact. Allergic, infective, psychological, and endocrinological influences may be interdependent and have antagonistic, or additive, or even synergic actions. Again, all these causative forces may be influenced by environmental stimuli which may be either nonspecific in their precipitating influences, or specific, e.g. an allergen to which the organism is sensitive. In these interactions, neurohumoral influences may play an important role. The immediate precipitation of an attack of asthma by emotional influences is probably mediated by the parasympathetic nervous system. The quantitative changes produced on allergic reactions by emotional states can be explained as the results of parasympathetic activity brought about by influencing vascular functions and by causing a release of acetylcholine, which, like histamine, can produce all the symptoms and tissue changes found in asthma and allergic disorders. The autonomic nervous system has important homeostatic functions, the parasympathetic having usually an anabolic and restorative function. It has been suggested that an asthma attack may be homeostatic, but it is difficult to see what homeostatic function an attack of asthma can have, and in fact it often imposes further strain on the body's homeostatic mechanism and may even cause death.

If asthma is regarded as an adaptive reaction, a possible teleological explanation would be that it represented an attempt on the part of the organism to shut out noxious agents, either actually or symbolically. Again, it is difficult to take a teleological viewpoint, as asthma is a serious, incapacitating, and not infrequently fatal illness. The pituitary-adrenal system also has important homeostatic functions. The production of glucocorticoids would tend to counteract the local damage caused

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by allergic, infective, and other noxious processes. In prolonged stress, the secretion of glucocorticoids may not keep pace with the production of mineralo-corticoids, as suggested by SELYE (1950), and this might favour the development of asthma in predisposed persons.

The final common path for all the pathogenetic agents in asthma would seem to involve acetylcholine and/or histamine. It is possible that the shock tissues show a hereditarily determined hypersensitivity to acetylcholine and histamine (JAROS, 1951). If this were so, it would explain many of the problems regarding organ or tissue specificity, and, for example, would account for the precipitation of an attack of asthma in an affected subject by emotional tension, rather than some other bodily manifestations of emotion. Genetic influences may also determine the degree of predisposition to neurosis and emotional instability (SLATER, 1942), and the tendency to autonomic imbalance (JOST and SONTAG, 1942). In asthma, genetic, constitutional, autonomic, endocrine, personality, neurosis, emotional tension, allergic, infective, and various environmental forces may be relevant and causal. These factors are interdependent and often show an intricate interplay in causing asthma.

In concluding, it may be said that for the adequate diagnosis and treatment of asthma, it is necessary, not only to consider the patient as a psychosomatic unity, but also the individual-environmental interaction as a continuum.

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SUMMARY AND CONCLUSIONS

1. The results of an investigation of 441 asthmatic subjects from physical and psychiatric aspects are described. Parallel psychiatric studies were carried out on 321 control subjects. In view of the importance of age and sex factors in the aetiology of asthma, care was taken to ensure that all asthmatic and control groups compared in age and sex distribution.

2. Concepts of aetiology are described, and the possible relevant and causal influences in the individual and his environment considered.

3. Asthma groups showed a statistically higher incidence of asthma and allergic disorders in parents and siblings than control groups.

4. While no specific personality types were found to be associated with asthma, there was a significantly higher incidence in asthmatic subjects compared with controls in the following: over-anxiety, timidity, over-sensitiveness, and marked obsessional traits.

5. Emotions were found to precipitate attacks in a high proportion of patients in all age groups in both males and females. The lowest incidence of emotional precipitation occurred in males aged 16–35 years. No specific emotional changes were responsible. All varieties of emotional tension, ranging from pleasurable excitement and elation to anxiety and depression were found. A high proportion of patients had inadequate expression of emotions, and suppression of any emotion was often found to be more important than the type of emotion experienced.

6. In each case the aetiological assessment was based on discussion and agreement between allergist and psychiatrist, taking into account all the physical and psychological findings. In the majority, more than one factor was responsible. It was found that a complex interplay and interdependence existed between allergic, infective, psychological, endocrinological, and environmental influence. The response of a person to an allergen is not always constant, and may be intensified by certain forms

of emotional tension. It is not only necessary to determine what substance a person is allergic to, but also why he has become sensitive, and why, at certain times, a more marked reaction occurs than others. Psychological and infective factors are considered to influence the intensity of allergic reactions. Similarly, emotional tension can produce changes in bronchial mucosa which are conducive to the development of infection, or which may intensify or prolong any existing infective process.

7. In children, parental influences are of paramount importance in the aetiology, management, and treatment of asthma. Parental attitudes of over-protection, rejection, and perfectionism due to a variety of causes were frequently present. These attitudes were such as to foster emotional tension in children, which may precipitate or aggravate attacks of asthma. The correction of faulty parental attitudes is a potent and effective therapeutic measure in treating many asthmatic children.

8. The role of the autonomic nervous system in allergy and asthma is described. The immediate precipitation of an attack of asthma by emotional tension is considered to be mediated by the parasympathetic nervous system. The possible role of autonomic nervous-system activity in the complex interplay of emotional, allergic, and infective processes, is discussed.

9. In the aetiology of asthma, genetic, constitutional, autonomic, endocrine, neurosis, emotional tension, allergic, infective, and various environmental forces may be relevant and causal. Many of these factors interact and are interdependent, and may be summative in action.

Acknowledgements—I am greatly indebted to Dr. D. A. WILLIAMS, Physician in Charge of Asthma Clinics, St. David's Hospital, Cardiff, for his untiring co-operation and provision of facilities throughout the investigation. I also wish to thank Dr. LEWIS FANING for statistical advice, and Dr. J. JACOBS and Mr. ALUN THOMAS for kindly providing some of the data on physical factors.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 115 to 119. Pergamon Press Ltd., London

PROBLEMS PRESENTED BY ASTHMA AS A PSYCHOSOMATIC ILLNESS

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Asthma, as a psychosomatic disease, exemplifies, perhaps more clearly than any other illness, the difficulties encountered in dealing with psychosomatic problems. The main question is to determine a dominant personality type in this illness. The evidence in the literature does not help us to clarify the matter, and the statements we can find are less explicit than those about any other psychosomatic disease. Perhaps the reason for this is simply the absence of any definite personality type amongst asthmatics. Although this point has not been adequately proved, any psychotherapist with some clinical experience is aware of the variety of personality types in which asthma can occur. In my own experience I have not found any definite personality type in asthmatics, in spite of the fact that among the selected population seen by a psychiatrist, one would expect a certain type to emerge more clearly, and yet this is not so. The physician in general practice is bound to find a greater variety of personality types.

Another objection against establishing an asthmatic personality is the frequent finding of other psychosomatic disorders in different phases in the life of these patients. Not unusually they suffered previously from colitis, episodes of precordial anxiety, obsessional symptoms, or, what is more, depressive phases. There are many other workers who find a description of psychosomatic profiles often vague and inadequate.

There are other solutions to the problem of asthma which we find difficult to accept. Alexander (1941) gives the interpretation of asthma as being related to an excessive dependence on the mother which has not been properly resolved. Saul (1946) goes further in his views, asserting a strong wish in these patients to return to intrauterine life, a point which Freud has already made. If we accept these views, we come up against the objection that the need for protection and the obscure tendency to regress to former phases of life is common to all neurotics, but is only expressed in different ways. In general, any interpretation trying to establish a psychogenic origin of asthma is insufficient. One often sees asthmatics in whom a psychic trauma produces an attack and, what is more significant, stops it. In one of my cases the attack was interrupted when the patient was told she was producing it by autosuggestion. But the same happens when the "status asthmaticus" is cut short by the administration of a placebo. Thus it seems as if there is a mysterious mechanism which is not always at our disposal. In some cases a relationship can be established, but not in others. It may be argued that such experiences are only meaningful in relation to previous ones, and that, as long as these are not uncovered, it is impossible to stop the attacks. However, psychoanalysts often fail to establish a relationship between asthmatic attacks and infantile conflicts. If we want to relate the conflicts to a desire to return to intrauterine life, we can say that in this case the individual cannot retain the memory as amnestic experience; this is shifting the

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ground considerably. Allergy is also in this case a form of biological experience, but then one has to explain why such a biological experience has to be relived, in an existential form, by means of other biological phenomena, one of which may be an attack of asthma.

To my way of thinking, the problem of asthma as a psychosomatic disease must take particular account of the frequently phasic occurrence of the disease, with at times the substitution of other psychosomatic disorders (neurocirculatory asthenia, migraine, etc.). In order to find a general explanation for this, some workers have resorted to an allergic interpretation of many psychosomatic conditions. Such an interpretation may be acceptable in some cases, such as when migraine replaces an asthmatic attack, but it is not so simple to understand when the change occurs between asthma and obsessional symptoms. This is one of the reasons why I have included in one large group a number of patients who are usually classed separately in general medicine, psychosomatics, and psychiatry, under the heading of vital or timopathic circle. In these patients the main disturbance is due to an alteration of the structure that gives rise to the instincts and vital feelings (fatigue, anxiety, malaise, sadness, etc.).

In some asthmatics I have observed the onset of agarophobic giddiness at times when they were free from asthma. Other patients relate dreams of a vertiginous character. Both symptoms seem to point clearly to the fact that in the asthmatic there is a change in his experience of space. Asthma is a form of introjected anxiety. Asthma means narrowness, and, in an attack of asthma, not only the bronchial tubes are narrowed, but also the breathable world. The experience can be compared with that of a claustrophobic patient for whom the world also becomes small. They are both similar modes of existence.

In other papers I have tried to clarify this point (LOPEZ IBOR, 1950). In a great number of cases the so-called neurotic anxiety is in fact physiogenic; in other words, not reactive but somatically produced. The origin of this anxiety is probably determined by the diencephalon. Many authors have accepted a similar view regarding the mechanism of an asthmatic attack. STURM (1948) maintains that asthma has a central origin. The finding in the patient's life history of anxiety crisis, vertigo, circulatory disorders, phobias or obsessions, amongst others, shows a possible common origin for all these disturbances.

I have seen periods of anxiety and vertigo, following periods of asthmatic attacks, which I think are also referable to the diencephalon. They represent, as it were, an alteration of claustrophobia and agarophobia. A sufferer from vertigo does not experience the anxiety of boundless space, but that of emptiness, of falling, or feeling faint. Similarly the asthmatic is not consciously aware of the space being narrowed, but this "narrowing" has been introjected. TROUSSEAU (1878) has described mental symptoms in asthmatics, which today we would class under claustrophobia.

Neurotic anxiety would then be a physiogenic anxiety elaborated at a personal level and consequently experienced in various ways, depending on the historical circumstances of the subject. This physiogenic anxiety I consider included in the timopathic circle, together with other disturbances which are characterized by oscillations of what SCHELER (1926) calls "vital feelings," such as happiness or sadness. We are dealing here with a clinical group similar to cyclothymia. Just

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as it is possible to differentiate a phasic sadness of vital character, there is also phasic anxiety of vital character. The relationship between asthma and the timopathic circle is demonstrated by the numerous cases in which an asthmatic phase appears replacing or following a vital depression, or an obsessional or phobic phase. BROWN and GOITEN (1943), in a study of the personality of asthmatics, found these patients had a cyclothymic disposition associated with paranoid features, repressed hostility, and ideas of self-punishment. Repressed aggression and a self-punishing attitude are, in my view, some of the numerous components of a developed anxiety crisis. MCDERMOTT and COBB (1939), in their work on asthma, emphasize a number of character traits such as cleanliness, punctuality, meticulousness, which are merely features of an anxious personality. In BOSS's (1954) anthropological interpretation of asthma, anxiety plays a very important role. Bronchial spasm, asphyxiation, and arrest of breathing are interpreted as a way of existence in a world overcharged with unbearable stimuli which reach a point of marked anxiety. The same applies to normal people in a heavy or noxious atmosphere: the response of the bronchial tubes is the same. Hence the return to the phase when the mother acted as a filter. These anthropological associations are based too much on the analysis of the situation, and they tend to disregard endogenous factors. A healthy person cannot breathe comfortably in an unhealthy atmosphere, but the asthmatic cannot breathe comfortably in a healthy atmosphere. The important thing to understand is why such a psychic or physical atmosphere becomes unhealthy for him. Is the source of intolerance in the atmosphere or in himself? The anthropological interpretation of the asthmatic crisis, establishing an analogy between the somatic and psychic levels, runs the risk of leading us into error, since it admits implicitly the same form of causality in both spheres. Physical causality is not the same as psychic determinism; the asthmatic crisis is like all crises, human and psychophysical: occurring simultaneously on both levels.

One of our patients, years after she had had asthmatic attacks, remarried and had a daughter. The birth produced a very severe anxiety crisis, and during it she developed a marked and persistent spasm of the neck of the uterus, to such a degree that a Caesarian section had to be performed. This suggests that the general phenomenon of "shutting off" and isolation would be also a general biological formula for certain patients, and that it would be projected on to different areas of neurological regulation.

What the asthmatic does in a crisis is to breathe in air which is not properly breathed out. Part of it is retained, and what he attempts to do is to expel it. The boundary which is established on the surface of the respiratory apparatus, between the subject and the world, is thus changed. The analogy with what happens in the obsessional patient is obvious. A patient suffering from an obsessional idea or impression finds that he cannot expel it from his mind. From the point of view of the symbolism of functions we must remember that breathing belongs, on the one hand, to the most rigid and unconscious automatism and, on the other, is clearly dependent on our volition, which is not the case with our circulation or digestion. This interaction of the will supposes the insertion of freedom, and probably in this way in ancient times breathing was related to the spirit.

Regarding the question of precipitation of asthmatic attacks, it is well known that attacks may be due to diverse and very curious mechanisms. One of my patients

had phasic attacks of asthma since childhood, always at 3 o'clock in the morning. On one occasion her husband decided to put the clock forward, but the patient woke up at the usual time, saying that she would soon have an attack. When told it was already 4 o'clock, the patient suffered no attack. Many similar examples can be found in the literature. It would be an error to pretend to solve the problem by calling it suggestion, and this is not because the term is faulty, but because it does not throw any light on the process involved. Such quick-acting suggestion is seldom seen in other illnesses; also, suggestion does not always work. In the case we mentioned, the trick of advancing the clock subsequently failed. Thus it appears that sometimes the patient is in a peculiar state of mind in which certain experiences are effective in response to that particular state.

The variety of personality types and circumstances in which an asthmatic attack can occur, show that this can be *overdetermined*, in the same way as the content of dreams, that is to say, they can play different roles of an unspecific kind in the individual life. If this is true, it would be, on the contrary, wrong to always attribute a fixed symbolism to the crises. The means of expression, either normal or abnormal, for a human being are inadequate compared with its enormous possibilities for action. Mental life absorbs the instinctual drives and transforms them into vital themes. The number of these is much richer than the basic instinctive structure. Every gesture is significant in a variety of ways. If this is the case with normal expressions, it must be all the more so with pathological mechanisms of an expressive character. The attack of asthma can be produced somatically—as in cardiac asthma—or mentally. If there is a multivalent somatic determinism, there is even greater multivalence in the psychic sphere. Hence the variety of personality types in asthma. We have then a variety of personalities which at a given moment use the more immediate mechanism of morbid expression.

One of my asthmatic patients had an enormous capacity for struggle, was ambitious, and anxious for power. On account of external circumstances, incidentally unjust, he had to abandon public life. He then developed asthmatic attacks, culminating in a "status asthmaticus." After the crisis he was able to reorganize his life, centring rather on values which were dependent on his own personality and less on external circumstances, all of which allowed him to become more adjusted.

This fact forces us to consider the problem of whether the "occasional apparatus," as BLEULER liked to call it, is predetermined in the patient. It seems very probable that this is in fact the case, and that in its production a number of factors intervene dependent on certain dispositions developed during early infancy. It seems to me that the asthmatic's first five years of life are worth careful analysis, such as that carried out by SPITZ (1950) in another group of patients.

The time of onset of asthmatic attacks, in relation to the development of the personality, deserves more attention than it has been given up to the moment. When one studies the development of personality in asthmatics throughout the years, marked differences are noticeable between them, not only in more or less permanent character traits, but in the way more variable ones unfold throughout their lives. I believe that such a study would throw a considerable amount of light on the prognosis of asthmatic patients. Something similar occurs in many other psychosomatic illnesses. Many asthmatics develop isolated crises appearing throughout their lives, others become chronic. Finally, in another group, to which I particularly

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wish to draw attention, the crises cease or lessen, but the personality gradually changes. Some of my patients have been cured of their asthma, but they have then shown themselves as psychopathic or abnormal personalities, to such a degree that they required in-patient treatment.

I am inclined to think that the psychosomatic study of asthma—and of other illnesses—will advance much further if the limits of the so-called psychogenesis were taken into account. By psychogenesis one must understand an alteration produced by an experience, and it implies that the elimination of that experience would be enough to suppress the disturbance. (In psychoanalytic doctrine the interpretation is complicated by the addition of repressed experiences.) In fact, psychotherapeutic experience shows this is not always the case, and that the suppression of a conflict which is a determinant in the illness, or the recognition of a past experience, is not enough to produce a cure. In fact, very often psychic conflicts only act as *catalysts*. Their presence unleashes the disorder, but their absence does not cure it, and once the disorder is produced it takes its course unaffected by psychotherapy. In such cases one must admit that the corresponding nervous regulation takes its course autonomously, because it is not intrinsically linked with the precipitating experience. In many anxiety states and depressives we find a similar situation. An emotional shock produces the appearance of an anxiety crisis, but once produced it follows its own autonomous course. In fact, what the shock has done is to crystallize an abnormal mental state of a vital origin; or, to put it in another way, a physiogenic state which was already on the move. But this is not only noticeable in the case of vital illnesses. It is also noticeable in others which are clearly neurological. We have all seen the symptoms of Parkinsonism or spasmodic torticollis which appear to follow an emotional shock. However, no one would dare to speak today in such cases of psychogenic Parkinsonism. The shock has played a part, but one not strictly causal. I propose to call this action *catagenesis* (from the greek "cata," downwards). We are dealing here with a disturbance which takes place at the somatic level, "descending" or coming down from the psychic. In asthma we frequently find catagenic actions which set in motion a deep morbid state of affairs which already existed. In some asthmatic patients a careful anamnesis uncovers infancy episodes of bronchitis of an asthmatic type. Afterwards a highly charged experience can set in motion or reveal what already existed; the experience has not produced it. To speak in such cases of psychogenesis is inadequate.

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THE ELECTROENCEPHALOGRAM IN CASES OF BRONCHIAL ASTHMA

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VARIOUS theories concerning the pathogenesis of attacks of asthma have involved the nervous system, and indeed, until 1910, asthma was classified as a neurosis in OSLER's textbook of medicine. One of the best monographs on the subject of asthma is that by HENRY HYDE SALTER (1860) which, although published almost one hundred years ago, is remarkably modern in its approach to the problem. In the second chapter SALTER writes: "What I shall endeavour to show is this: that asthma is essentially and with perhaps the exception of a single class of case, exclusively a nervous disease: that the nervous system is the seat of the essential pathological condition." Although this concept has fallen somewhat out of fashion since the rise of our knowledge of allergy, there is a substantial body of evidence (LEIGH, 1953) to indicate that serious consideration must still be given to the investigation of nervous function and disorder in patients suffering from bronchial asthma.

Since 1936, the electroencephalograph has been increasingly used as a tool of neurophysiological research; it is a sensitive indicator of certain aspects of nervous-system activity, although its limitations are well recognized. What then are the electroencephalographic findings in patients with bronchial asthma? A certain amount of work has been carried out over the past ten years, with somewhat contradictory findings, and a re-examination of this problem might be worthwhile.

MATERIAL

Since 1949 a study of asthmatics has been in progress, and to date 140 patients have been investigated. Many of these have been followed up for several years, and various investigations have been carried out. All the patients had been referred to one of us, a psychiatrist with a particular interest in the problem of bronchial asthma. The diagnosis of bronchial asthma had been made in all cases by a physician elsewhere, and in most cases full physical and radiological examinations had been made. The criteria for the diagnosis adopted here by the clinician are recurrent attacks of expiratory dyspnoea, with wheezing, occurring in the absence of any demonstrable disease of heart, lungs, and kidneys. Physical examination, radiology, skin tests, blood counts, and sedimentation rates were carried out, and the patients were subjected to a standard psychiatric examination. Of these 140 patients, 55 were selected at random for electroencephalographic examination.

There were twenty-nine women and twenty-six men, the ages ranging from 16 to 56, mean age of both groups being 33 years. Their clinical status was almost identical; taken together, there was a family history of allergy in just over half, a personal history of allergy in two-thirds, and some positive reaction to skin tests (Bencard) in two-thirds. The duration of the asthma varied from five months to thirty years.

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Their psychiatric status is of some importance for this study, as it can be said that an undoubted selection has taken place, for all these cases had been referred primarily to a psychiatrist with a particular interest in asthma. However, this element of selection does not imply that all these cases presented as psychiatric problems. They came from a wide area around London, from many sources, with, as often as not, no mention of psychiatric illness from the referring physician. In fact, two-fifths of the women and about two-thirds of the men were considered by the psychiatrist to suffer from a classical neurosis or psychosis. Five of the men and three of the women were psychotic in the sense that they suffered from an endogenous depressive or schizophrenic illness; twelve men and nine women were neurotic or delinquent. There was a family history of psychiatric illness in a near relative (here defined as parents, grandparents, uncles, aunts, and siblings) in 43% of the group. The problem of

TABLE 1.—SEX AND AGE-RANGE OF ASTHMA CASES AND CONTROLS
(Age in years)

		—20	21–25	26–30	31–35	36–40	41–45	46–50	51+	Total
Asthma	Male	2	3	7	5	5	2	0	1	25
	Female	2	5	4	3	3	7	3	3	30
Controls	Male	0	8	13	7	6	1	1	0	36
	Female	1	7	4	8	6	4	1	1	32

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psychiatric symptoms in asthmatics is one which has been insufficiently investigated, but work to be published (LEIGH and MARLEY) will show that psychiatric symptoms are extremely common in asthmatic patients. It is probable, however, that some selection has occurred in this group.

The control group consisted of sixty-eight patients suffering from psychiatric disorders, who had been referred to the e.e.g. department by the physicians of the hospital. The fact that they had been referred for an e.e.g. necessarily again implies some degree of selection, for the great majority of psychiatric patients at the hospital do not have an e.e.g. examination. In these sixty-eight patients, most had been referred owing to some form of attack, or of abnormal behaviour or the suspicion of an organic disorder. However, no case was included in which it was certain, or even likely, that either epilepsy or an organic lesion was present. The ages ranged from 19–52; mean age, 31·8. There were thirty-two women and thirty-six men (Table 1). The clinical diagnoses were neurosis in two-thirds, psychopathy in just less than one-third, and depressive psychosis 6 (9%). In ten patients (14·7%) there was a family history of epilepsy. In none was there any family history of asthma or allergic disorder.

E.E.G. OBSERVATIONS

The e.e.g. studies were carried out according to the routine of the Department of Clinical Neurophysiology, using a standard 20-electrode placement and both antero-posterior and transverse bipolar recording positions. Routinely, overbreathing for

three minutes and photic stimulation over the range of frequencies from 4–20 c/s were carried out. The criteria of abnormality correspond to those described in HILL and PARR (1950). The following table shows the incidence and types of abnormalities found in the asthma group and the control group (Table 2).

TABLE 2

Electroencephalography findings	Controls	Asthmatics
Excess generalized 4–7 c/s	15 (22%)	16 (29%)
Excess 4–7 c/s 14+ c/s	5	3
"Alpha variant"	3	1
Sharp waves	1	1
Excess 14+ c/s	0	1
Focal 4–7 c/s	3	0
Normal	41	33
Total abnormal	27 (39%)	22 (40%)

It is to be noted in both cases that diffuse 4–7 c/s (theta) activity is the commonest abnormality; the other minor variations of excess, fast as well as slow activity, sharp waves, and posterior slow activity blocking to eye opening ("alpha variant"), are also found in a small proportion of the neuropsychiatric population generally. Figs. 1–3 illustrate some of these findings.

In no case of asthma were any abnormalities of a specific epileptic kind effected by photic stimulation, nor were any additional abnormalities induced by overbreathing. One of the asthma cases showed a myoclonic response of the frontal and eye muscles, which BICKFORD (1952) and his co-workers have called the photomyoclonic response, This is a nonspecific response, and found in all types of patients.

DISCUSSION

The first paper written on the e.e.g.'s of asthmatics was published in 1944 by RUBIN and MOSES. Their study is based on older work of SAUL, DAVIS, and DAVIS (1937), who showed that a high alpha index (i.e. the per cent time that alpha rhythm could be counted in standard-time records) was correlated with passivity of personality. This type of work has never been followed up, as interest has shifted away from the attempt to find such correlations. Although in their paper RUBIN and MOSES stated that there was a marked difference in the alpha per cent time between their group of patients and some normal controls, they quoted a further study in a footnote which is based on a much larger series of normals. The difference between this normal group and their asthmatics is much less obvious and of doubtful statistical significance. They mention in passing that only three of their cases had abnormal e.e.g.'s. However, they

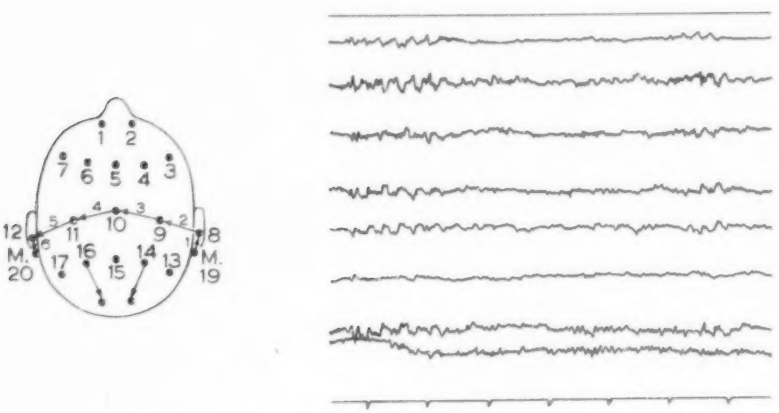

FIG. 1.—Paroxysmal activity at 3–4 c/s with sharp waves. 1 cm = 50 V.
Time marker 1 second. F. M. L., æt. 32, 22.9.54.

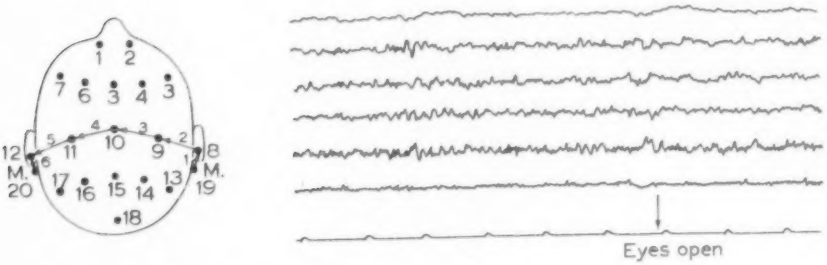

FIG. 2.—Slight excess of intermediate slow activity. 1 cm = 50 V.
Time marker 1 second. P. L. R., æt. 20, 23.7.53.

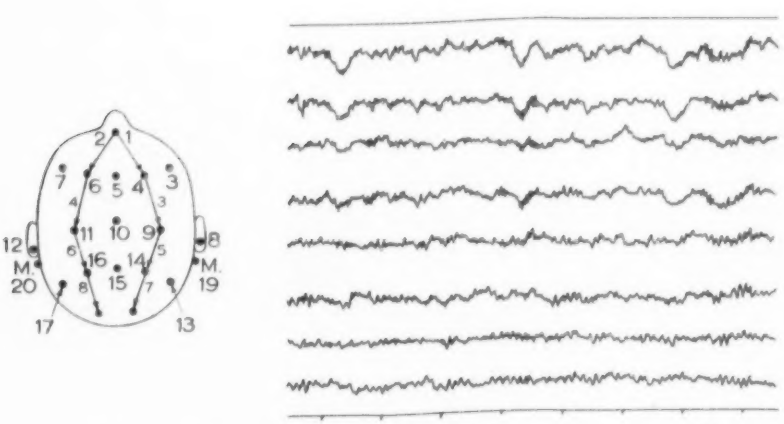

FIG. 3.—Unusual amount of frontal fast rhythm for the age. 1 cm = 50 V.
Time marker 1 second. L. D. K., æt. 30, 21.7.53.

used specially tuned filters largely designed to show up the alpha activity, since this is what they were mainly interested in. Such recording would naturally diminish the prominence of faster and slower activity.

Four years later, in 1948, DEES and LOWENBACH reported their findings in eighty-five children, age 2–14, suffering from various types of allergy; fifty-six of them were asthmatics. A nonallergic control group was used. A remarkable finding was that roughly one-quarter of the allergic group had a convulsive disorder for which no immediate cause could be demonstrated. Another quarter suffered from a behaviour disorder. Thus over half of the group presented neuropsychiatric disabilities. Unfortunately, it is impossible, from the mode of presentation, to distinguish the allergic status of these patients, as it seems that the authors regarded their cases of epilepsy as allergic. The e.e.g. findings must, therefore, be interpreted with great caution. One-quarter of the group had normal e.e.g.'s, half showed an occipital dysrhythmia, the remaining quarter encompassed all types of abnormalities. Two factors appeared to have a definite correlation with a high incidence of occipital dysrhythmia, the presence of a positive family history of allergy, and the duration of the allergic disorder. The longer the duration, the higher the percentage of patients showing changes in the occipital pattern. DEES and LOWENBACH pointed out that the incidence of abnormalities in the e.e.g. tends to decrease with increasing age, but why the parieto-occipital electrical activity, which is the most stable and repetitive of the regional patterns in adult life, should be affected, is difficult to understand. They suggested that a good deal of the psychological difficulties of the allergic child might be explained, on their findings, by a central nervous system which does not function smoothly and efficiently. Since occipital dysrhythmia and other types of abnormality were present in much the same proportions in patients with allergy complicated by behaviour problems and convulsions, as in those children with allergy only, it seems likely that the allergy may be expressed in an abnormal e.e.g. In 1950, CHOBOT, DUNDY, and PACELLA substantially repeated the work of DEES and LOWENBACH. Eighty allergic children (age 2–14) were studied, fifty-two of them asthmatics. Of the eighty e.e.g.'s, fifty-four were completely normal and twenty-six abnormal. In the asthmatic subgroup thirty-six were normal and sixteen abnormal; roughly one in three asthmatics showed an abnormal e.e.g. An interesting byproduct of the study was the attempt to investigate the families of these children. Forty-two tracings were obtained, of which sixteen were abnormal, an incidence of approximately 40%.

These authors point out that the electroencephalograms of children are difficult to assess, since norms have not been well established. The older the child the less uncertain the interpretation of a record. However, by using the definite criteria of abnormality proposed by GIBBS and GIBBS (1941), they noted a greater incidence of slow potentials, at times in serial bursts, than amongst normal children. They rejected the "occipital dysrhythmia" of DEES and LOWENBACH, as it is often found in normal children. A definite preponderance of abnormalities appeared in the girls, as opposed to the boys, and there was a high incidence of abnormal patterns in the families of allergic children. No correlation could be observed between the clinical types of allergy and the e.e.g. patterns which had been found.

In 1952 two further papers were published in Europe, the first by GROSSI-BIANCHI, consisting largely of a discursive and speculative discussion on the possible hypothalamic changes that could be related to the vegetative disorders underlying the

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allergic state. She briefly mentions, however, that in an unspecified number of children suffering from allergy, chiefly asthmatics, 60% had an occipital dysrythmia, and 70% had a paroxysmal dysrhythmia, either spontaneous or provoked by over-breathing, which largely consists of slow, high voltage waves at between 4–6 cycles per second. A slow paroxysmal dysrhythmia on overbreathing is not abnormal in children. One case of asthma was accompanied by convulsions, and e.e.g. changes of an epileptic type. The second paper, by PANZANI and TURNER, working in Marseilles, reported on forty-two adults and thirty-five children suffering from asthma. In the adults, 55% had abnormal e.e.g.'s, the majority showing desynchronization, a form of record similar, if not identical to that described by GIBBS and GIBBS as "low voltage fast" activity. In Marseilles such records are regarded as evidence of a clinical syndrome of "Hyperexcitabilité neuronique"—for which an exact counterpart does not exist in Anglo-Saxon medical terminology. 40% of the children had abnormal e.e.g.'s, in nine the records contained an excess amount of slow activity, and in three there were specific epileptic discharges. Arguing on current neurophysiological work, PANZANI and TURNER postulated a "Mécanisme nerveux surtout diencéphalique" in cases of asthma which must be taken into account in any consideration of the totality of the pathogenesis of this condition.

In 1953, HOLMGREN and KRAEPELIEN reported on one hundred asthmatic children aged 2–15 years. 36% of these were said to have abnormal e.e.g.'s. Three showed focal spikes or sharp waves, and three generalized wave and spike. No sex difference was noted nor was there any correlation between the age of onset and the duration of the asthma and the frequency of abnormal e.e.g.'s. On the other hand, the proportion of abnormal e.e.g.'s increased with the severity of the asthma. The records were taken in asthma-free periods, so that the changes observed were not directly related to the attack of asthma itself. One record, however, was taken during a severe status asthmaticus, and was markedly abnormal, showing slow ¾-c/sec waves of high voltage. The samples of the e.e.g.'s which illustrate this paper show a slow activity of a type that is frequently noted in children suffering from a behaviour disorder in the absence of any evidence of organic disease. Whilst fully recognizing the difficulties of establishing criteria of normality for the different age-groups, HOLMGREN and KRAEPELIEN point out that only 5% of a "normal" population of 150 children showed dysrhythmic records similar to those of the asthmatic patients. The possibility of repeated attacks of cerebral hypoxia being related to the e.e.g. changes is discussed by these authors, the question arising as to whether the hypoxia occurs as a result of failing pulmonary activity, or of allergic vascular changes. PANZANI (1953) has also recently published a brief paper of his findings in 126 asthmatics—forty-eight children and seventy-eight adults. His most important observations are that epilepsy and asthma have only exceptionally a common origin, and that a "mesodiencephalic" factor is incontestable in cases of asthma. His general findings have been already noted.

From this review of the literature there appear to be considerable discrepancies in the e.e.g. findings, both in adults and in children; the earlier studies tended to show more alpha rhythm than usual, whereas the later ones report an excess of slow activity. Unfortunately, no adequate controls have been used, for although "normals" were contrasted with allergic patients in several studies, no control series of psychiatric patients were used. In view of the importance of psychological factors in asthma, this seems an essential methodological consideration in any e.e.g. study of asthma.

In our own study of fifty-five adult asthmatics, thirty-three had normal records, sixteen (29%) showed a moderate excess of intermediate slow (theta) activity, and the remaining six presented minor anomalies such as the occipital slow-wave dysrhythmia which is here called "alpha variant" (a total of 40% abnormal). These findings may be contrasted with those obtained from a group of sixty-eight psychiatric patients, made up equally of men and women, ranging in age from 19–52. For reasons already set out, the diagnoses were mainly those of psychopathic states or severe neurosis. Twenty-seven (39%) of this group had abnormal records, which corresponds exactly to our overall findings in the asthmatics. 22% showed theta activity as contrasted with 29% of the asthmatic group, and the rest showed the type of relatively non-specific anomalies we have mentioned. These figures may also be compared with those published by HILL and PARR (1950), based on older data from this hospital.

Our findings refer to adult asthmatics only. Experience with a large group of behaviour problem children at this hospital, however, shows that the type of e.e.g. disorder reported as occurring in asthmatic children is also frequently encountered in these psychiatrically disturbed children. It is hoped that a study of child asthmatics may be carried out to elucidate this. From our material, therefore, it appears that there is nothing to differentiate the e.e.g. abnormalities found in adult asthmatics from those found in a group of patients suffering from neurosis or personality disorders. The proportion of abnormality is certainly high, being comparable with that found in the psychopathic group, who in any case show a relatively higher incidence of e.e.g. disorder than do neurotic patients. The reason for this is not clear. It is possible that a small proportion of the abnormal records found in asthmatics may be due to definite cerebral lesions, perhaps the result of repeated episodes of hypoxia, rather than to the constitutional and genetic factors which seem to be responsible for most of the anomalies seen in the type of psychiatric population we have used as a control group. On the other hand, the frequency of a history of psychiatric disorder in the antecedents of asthmatics (LEIGH, 1953) and the genetic nature of bronchial asthma, suggests that we are dealing with a constitutional anomaly of the e.e.g. Further work on the psychiatric genetics of asthmatics may throw further light on this problem.

CONCLUSIONS

1. The e.e.g.'s of fifty-five adult patients suffering from bronchial asthma were examined and contrasted with a group of psychiatric patients, matched for age, sex, and social status.

2. Of the asthmatics, 60% had normal records, 30% showed an excess of intermediate slow activity, and 10% showed minor anomalies.

3. Almost identical changes were found in the psychiatric population examined.

4. The significance of this finding has been discussed.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 128 to 136. Pergamon Press Ltd., London

A PSYCHIATRIC ASSESSMENT OF ADULT ASTHMATICS: A STATISTICAL STUDY

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THE common symptoms of which the asthmatic patient complains refer to the asthmatic attack, the tightness, the wheezing, and the respiratory difficulty taking pride of place. The more experienced the physician in the care of asthmatics, however, the more he becomes aware of the protean-like nature of the asthmatic symptomatology. Indeed, even those symptoms directly referable to the asthmatic attack may vary considerably from patient to patient. As often as not, for instance, the patient complains of inspiratory rather than expiratory difficulty. Symptoms are the subjective impressions of the patient, and as such, are expressed in a manner which reflects the personality and cultural level of the individual. There may be a basic similarity in the symptoms associated with a particular disorder, but when emotional factors enter into the disorder, then clearly there is a much greater range of subjective impression. The very fact that clinical diagnosis is based on the combination of symptoms and signs makes it imperative to study symptoms and their formation as closely as possible. A study of the psychiatric symptoms of the patient with bronchial asthma has been particularly neglected, and this paper is an attempt to remedy this shortcoming. We hope it will serve a useful purpose in two main respects. Firstly, psychiatric symptoms are most often the basis for the referral of the asthmatic by the general physician to the psychiatrist, and secondly, we hope it may shed some light on the relevance in general of psychiatric factors in this disorder.

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METHOD

The Cornell Medical Index Health Questionnaire was selected, as it contains a large body of significant medical and psychiatric data which have been validated. It is easy to administer and is as acceptable to groups of patients at general hospitals as it is to those at psychiatric hospitals, or to workers in large stores. It is a four-page printed form, containing 195 questions all in colloquial English, and all to be answered by a Yes or a No. The patient answers the questions by circling the appropriate answer. Questions are of four kinds, and relate to bodily symptoms, past illnesses, family history, and behaviour (mood or feeling). The questions are arranged in sections, as illustrated in Table 1. There is a form for men and one for women, both being identical apart from six questions concerning genito-urinary function. The questionnaire is self-administered, the patient completing it whilst waiting in the clinic. The average time needed is 10–20 min. In ordinary clinical practice it forms a useful guide to the patient's symptoms; it has also a research function when used in the manner of this investigation. Full details of the questionnaire have been published by BRODMAN *et al.* (1949).

Four main groups were selected: (1) A group of asthmatics attending a general physician at a general hospital; (2) A group of asthmatics attending a psychiatrist at the Maudsley Hospital; (3) A group of neurotic patients attending the same psychiatrist at the Maudsley Hospital; (4) A group of workers at a large London departmental store employing 15,000 workers. These were used as normal controls. Each group was subdivided into males and females, so that eight comparable groups were finally available. The C.M.I. was given to all these individuals, for whom, apart from the controls, there was also available an adequate clinical record.

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The results included in this investigation are derived from the last portion of the questionnaire, that is sections M–R (fifty-one questions). These are representative, according to BRODMAN *et al.*, of mood and feeling patterns. These include inadequacy (M), depression (N), anxiety (O), sensitivity (P), anger (Q), and tension (R).

TABLE I.—THE SECTIONS ON THE CORNELL MEDICAL INDEX

Section	Questions referring to:	Number of Questions
A	Eyes and ears	9
B	Respiratory system	18
C	Cardiovascular system	13
D	Digestive tract	23
E	Musculoskeletal system	8
F	Skin	7
G	Nervous system	18
H	Genito-urinary system	11
I	Fatigability	7
J	Frequency of illness	9
K	Miscellaneous diseases	15
L	Habits	6
	Mood and feeling patterns	
M	Inadequacy	12
N	Depression	6
O	Anxiety	9
P	Sensitivity	6
Q	Anger	9
R	Tension	9
	Total	195

Two groups of results were analysed;

(1) the comparison of the mean values for the total of the sum of the positive responses for sections M–R (analysis of the total responses) and (2) the comparison of the mean values for the total of the positive responses for each of the six separate sections M, N, O, P, Q, and R (analysis of the individual responses).

The significance of the difference between the means of the results obtained was assessed by STUDENT'S "*t*" test for uncorrelated data.

OBSERVATIONS

The number and composition of the groups is illustrated in Table 2.

The patients attending the general hospital (King's College Hospital), and the psychiatric hospital (The Maudsley Hospital) are derived from the same social groups. The hospitals face each other across Denmark Hill, serve the same London areas, and are both teaching hospitals associated with the University of London. The matching of the controls was done in the following way. Dr. H. M. BALFOUR, medical officer to a large London store, was asked to obtain approximately one-hundred completed questionnaires. As this store contains representatives from every social group, the selection was left to Dr. BALFOUR of "normal" workers in every department

TABLE 2.

Group	Mean age		Age range		Number	
	Males	Females	Males	Females	Males	Females
Maudsley asthmatics	32·8	33·8	12–51	17–59	35	42
King's College Hospital asthmatics	37·3	35·8	13–61	15–64	28	37
Normal controls	36·5	34·5	19–64	17–56	48	56
Neurotic controls	33·9	34·6	22–53	18–63	46	72

TABLE 3.—SIGNIFICANCE OF THE DIFFERENCES BETWEEN MEANS FOR THE TOTAL RESPONSES ON THE C.M.I.

Groups	Males			Females		
	t	*p*	Significance	*t*	*p*	Significance
Normals and K.C.H. asthmatics	2·49	<0·01	+	3·22	<0·005	+
Normals and Maudsley asthmatics	6·32	<0·005	+	3·80	<0·005	+
K.C.H. asthmatics and Maudsley asthmatics	2·80	<0·005	+	0·708	>0·20	−
Maudsley asthmatics and neurotics	1·17	>0·10	−	2·14	<0·025	+
K.C.H. asthmatics and neurotics	3·80	<0·005	+	3·07	<0·005	+
Normals and neurotics	7·37	<0·005	+	7·31	<0·005	+

We considered that the control group obtained in this way was extremely satisfactorily matched for age, sex, and social status.

The analyses of the total responses for the males and females are shown in Table 3.

From these figures it will be seen that in the men the mean of the K.C.H. asthmatics responses is significantly different from that of the normals, the Maudsley asthmatics and the neurotics. The mean of the Maudsley asthmatics responses is significantly different from that of the normals and of the K.C.H. asthmatics, but not significantly different from that of the neurotics. The mean of the responses of the neurotics is

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significantly different from those of the normals and of the K.C.H. asthmatics, but not significantly different from that of the Maudsley asthmatics. These findings lead to the conclusion that the Maudsley asthmatics are more neurotic than the K.C.H. asthmatics, and the mean of their total responses could be predicted to fall within the neurotic group. The mean for the K.C.H. asthmatics, although significantly different

TABLE 4.—SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS FOR THE INDIVIDUAL RESPONSES ON THE C.M.I.

Males

Groups		Individual responses					
		M	N	O	P	Q	R
Normals and K.C.H. asthmatics	*t*	3·19	0·16	1·25	0·99	1·84	2·36
	p	<0·005	>0·45	>0·10	>0·15	<0·05	<0·01
	Significance	+	—	—	—	+	+
Normals and Maudsley asthmatics	*t*	4·35	2·70	5·58	4·85	5·46	4·15
	p	<0·005	<0·005	<0·005	<0·005	<0·005	<0·005
	Significance	+	+	+	+	+	+
K.C.H. asthmatics and Maudsley asthmatics	*t*	1·14	2·05	3·53	3·21	2·76	1·39
	p	>0·10	<0·025	<0·005	<0·005	<0·005	>0·05
	Significance	—	+	+	+	+	—
Maudsley asthmatics and neurotics	*t*	1·20	1·09	0 02	0·02	0·39	2·45
	p	>0·10	>0·10	>0·45	>0·45	>0·30	<0·01
	Significance	—	—	—	—	—	+
K.C.H. asthmatics and neurotics	*t*	2·35	2·91	3·63	2·72	2·51	3·79
	p	<0·10	<0·005	<0·005	<0·005	<0·01	<0·005
	Significance	+	+	+	+	+	+
Normals and neurotics	*t*	5·90	3·93	5·70	3·82	4·54	4·93
	p	<0·005	<0·005	<0 005	<0·005	<0·005	<0·005
	Significance	+	+	+	+	+	+

\+ significant difference between means.
— insignificant difference between means.

from the mean for the normals, nevertheless would not fall into the neurotic group, i.e. K.C.H. asthmatics are not neurotic, although they might well be considered to be half-way to neuroticism.

For the women, the mean for the responses of the K.C.H. asthmatics is significantly different from that of the normals, significantly different from that for the neurotics, but not significantly different from that for the Maudsley asthmatics. The mean for the Maudsley asthmatics is significantly different from that of the normals and that of the neurotics, but not from that for the K.C.H. asthmatics. The mean for the responses of the neurotics is significantly different from that for the normals and from those for both groups of asthmatics. In this case it can be seen that although both the means

for the K.C.H. and Maudsley asthmatics are significantly different from that for the normals, they can in no way be considered to fall into that for the neurotics. Thus the female asthmatics are more homogeneous in their responses than are the two equivalent male groups, and their responses might well be considered to lie at a half-way stage to neuroticism.

TABLE 5.—SIGNIFICANCE OF THE DIFFERENCES BETWEEN MEANS FOR THE INDIVIDUAL RESPONSES ON THE C.M.I.

Females

Groups		Individual responses					
		M	N	O	P	Q	R
Normals and K.C.H. asthmatics	*t*	2·39	2·52	4·72	2·05	1·09	2·59
	p	<0·01	<0·01	<0·005	<0·025	>0·10	<0·005
	Significance	+	+	+	+	—	+
Normals and Maudsley asthmatics	*t*	2·26	2·74	5·56	1·58	2·51	3·62
	p	<0·025	<0·005	<0·005	>0·05	<0·01	<0·005
	Significance	+	+	+	—	+	+
K.C.H. asthmatics and Maudsley asthmatics	*t*	0·02	0·18	1·26	0·49	0·61	1·14
	p	>0·45	>0·40	>0·10	>0·30	>0·25	>0·10
	Significance	—	—	—	—	—	—
Maudsley asthmatics and neurotics	*t*	1·96	3·51	0·75	1·55	1·48	1·33
	p	<0·025	<0·005	>0·25	>0·05	>0·05	>0·05
	Significance	+	+	—	—	—	—
K.C.H. asthmatics and neurotics	*t*	2·01	3·01	2·23	0·89	3·15	2·75
	p	<0·025	<0·005	<0·025	>0·15	<0·005	<0·005
	Significance	+	+	+	—	+	+
Normals and neurotics	*t*	5·25	4·15	7·28	2·32	4·72	6·19
	p	<0·005	<0·005	<0·005	<0·01	<0·005	<0·005
	Significance	+	+	+	+	+	+

\+ significant difference between means.
— insignificant difference between means.

The results for the analysis of the individual responses are presented below, those of the males being included in Table 4 and those for the females in Table 5.

Males

The findings show that the means for the K.C.H. asthmatics are significantly different from those of the normals in subgroups M, Q, and R, significantly different from those of the Maudsley asthmatics in subgroups N, O, P, and Q, and in all subgroups from those for the neurotics. The mean values for the Maudsley asthmatics are significantly different from those of the normal controls in all subgroups, significantly different in subgroups N, O, P, and Q from the means for the K.C.H.

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asthmatics, and significant in difference in subgroup R only from the mean values obtained for the neurotics. The mean values for the subgroups in the neurotics are significantly different from those for the normals in all instances, significantly different in all subgroups from the means for the subgroups in the K.C.H. asthmatics, but not significantly different in any of the subgroups from the means for the Maudsley asthmatics except for R.

Conclusions—These findings suggest that the K.C.H. male asthmatics show more inadequacy, anger, and tension than normal controls, that they are just as inadequate and tense as the Maudsley male asthmatics, but that the latter's responses reveal significantly more depression, anxiety, sensitivity, and anger. In addition, whereas the male K.C.H. asthmatics are significantly different in all subgroups from the male neurotics, the Maudsley male asthmatics are different only from the male neurotics in that they are less tense. That is, the similarity of the Maudsley male asthmatics and the male neurotics observed in the analysis of the total responses is confirmed from the assessment of the individual responses.

Females

Here the mean values for the individual responses for the K.C.H. asthmatics are significantly different from those of the normal females in all subgroups except Q, are not significantly different in any of the subgroups from those of the Maudsley asthmatics, and are significantly different from the neurotics in subgroups M, N, O, Q, and R. The means for the individual responses of the Maudsley asthmatics are significantly different in all subgroups from those for the normal controls except for P, not significantly different in any subgroup from those for the K.C.H. asthmatics, and significantly different from the neurotics in subgroups M and N. The mean values for the individual responses for the neurotics are significantly different from those of the normal controls in all subgroups, significantly different from the K.C.H. asthmatics in all subgroups except P, and significantly different from the Maudsley asthmatics in subgroups M and N.

Conclusions—The analysis of the individual responses for both groups of female asthmatics reveals no significant dissimilarity. However, the K.C.H. female asthmatics show more inadequacy, depression, anxiety, sensitivity, and tension than normal female controls, whilst the Maudsley female asthmatics are significantly different from the normal controls in that they show more responses for inadequacy, depression, anxiety, anger and tension. As with the males, the Maudsley female asthmatics approximate closer to the neurotic female patients than do the K.C.H. female asthmatics.

DISCUSSION

The surprising dearth of information with regard to the psychiatric symptomatology of the asthmatic has already been remarked (LEIGH, 1953). Psychiatrists seem to have been more concerned with psycho-pathological theory than with symptom analysis, and yet it is largely on the basis of a patient's symptoms that the physician refers a patient to a psychiatrist. Vague and general statements abound, and only a few papers are relevant to this topic. POLLNOW, WITTKOWER, and PETOW (1929), in their study of the psychotherapy of bronchial asthma, noted that twenty-three of the forty-five patients presented "psychopathic features". DUNBAR (1938) considered, after treating three asthmatics psycho-analytically, that they were obsessional

neurotics, who developed phobic and obsessional symptoms in periods of freedom from asthma. MCDERMOTT and COBB (1939) studied fifty asthmatics, twenty-two males and twenty-eight females. Approximately 60% of the group had symptoms which would be classified as "neurotic," that is, they showed irritability, easy arousal to anger, and a whining or complaining attitude. There is some confusion between personality traits and symptoms, however, for, in a later section of the article, neurotic traits usually of a compulsive type seem to have been equated with symptoms. In 1941, SCHATIA published her paper on the incidence of neurosis in cases of bronchial asthma. She gave the Rorschach test to forty asthmatics, thirty-two women and eight men; her results showed that the asthmatic suffered from a neurosis of an obsessive type. As her conclusion is based on Rorschach responses, about which there is no measure of agreement amongst psychiatrists, and as many of the clinical histories do not in fact suggest obsessional neurosis, the paper is far from convincing. In 1948, TRUETING and RIPLEY investigated a total of fifty-one asthmatic patients, twenty-eight women and twenty-three men. Here again there is no clear differentiation between symptoms and personality traits. However, depression was found to be "almost universal" in all patients during attacks of asthma. A smaller number were in a state of depression most of the time, whilst anxiety was a prominent feature in 60% of the cases.

The depressive mood of the asthmatic has been noted by many authors, and psycho-analytic writers in particular have considered it of etological importance. Indeed, the problem of psychotic illness and asthma has been given considerable prominence in the psychiatric literature. There are many reports of psychotic illness and asthma occurring in the same patient. All types of psychotics—paranoid, manic depressive, and schizophrenic—are encountered, so that psychotic symptomatology (delusions, hallucinations, or severe depressive manifestations, for example) will present in a small proportion of patients. The exact proportion is difficult to estimate, as all the information available is based on the occurrence of asthma in already disturbed mental patients. LEIGH and DOUST (1953) found the incidence of asthma in a mental hospital to be 0·64%, whilst MCINNIS (1936) discovered only five asthmatics amongst seven thousand psychiatric patients. SABBATH and LUCE (1952), and LEIGH and DOUST (1953), have recently reviewed the literature, and the latter authors have concluded that the relationship between asthma and psychosis is due to little more than chance. However, the incidence of psychosis amongst an asthmatic population has not, to our knowledge, been recorded. In the personal series attending the Maudsley Hospital, fourteen patients were diagnosed as suffering from psychosis, giving an incidence of 8·5%, but this is undoubtedly a much higher percentage than in the general asthmatic population, as the factor of selection in this group operates more markedly, the more florid the psychiatric disorder. Psychotic symptoms are probably no more common in an asthmatic population than in the general population, (LEIGH and DOUST, 1953). The depression so commonly observed in asthmatic patients is probably no more than reactive in nature, although there has been no decisive evidence as yet on this.

A monograph on Rorschach findings in asthmatics, using a control group and statistical methods (BARENDRECT, 1954) brings this review of the literature to a close. This observer considers that the asthmatic is a psychoneurotic; is more vulnerable, more rigid, less able to tolerate anxiety, and more impulsive than normals. Although these findings largely relate to personality, and the asthmatics studied were a very

highly selected, and on the whole, unrepresentative group (mean age 46·3 years), they were a psychoneurotic population.

This survey of the somewhat scanty literature reveals no satisfactory symptomatological analysis. Unfortunately, the distinction between symptoms and personality traits has mostly obscured the issue, the one often merging into the other. However, it would be unfair to imply that this study is entirely free from such faults, for the Cornell Medical Index is no paradigm, including as it does both symptoms and traits. This disadvantage is to some extent counterbalanced by the fact that the results have been weighed against those for a normal and neurotic population.

The thoughtful general physician is in a dilemma when he considers the referral of a patient to a psychiatrist. Is there a particular type of asthma, or a particular type of patient with asthma who would better be referred to a psychiatrist? From the material briefly presented here, analysing the total responses for the C.M.I. shows that the female asthmatic population attending a physician at a general hospital, and a psychiatrist particularly concerned with asthma at a psychiatric hospital, are substantially the same. Both groups differ significantly from groups of controls and neurotics—the asthmatics falling between the two. The male population was, however, very different. Those attending the psychiatric hospital were not significantly different from a control population of neurotics, whereas those attending the general hospital, although significantly different in their responses from the normal population, fall between them and the neurotics. The assessment of the meaning of the results for the individual responses is more problematical. In general terms, it can be stated that all groups of asthmatics in this particular study show more inadequacy and tension than do normal controls, whilst the asthmatics seen by a psychiatrist show significantly more depression and anxiety than do normal controls. Even so, no great specificity should be attached to these last conclusions, deriving as they do from both personality and symptom analysis; but in so far as they go, they are interesting in that they confirm some of the aspects of the work published by TRUETING and RIPLEY (1948).

These findings are of considerable interest theoretically, as the majority of the psychiatric group are treated both psychotherapeutically and medically. This is, of course, because there is a need for psychotherapy. It suggests that the physician who considers asthma as primarily an allergic disorder may well be mistaken. It accents the need for teamwork in this disorder, and that team should consist of physician and psychiatrist. An analysis of detail is in progress and may perhaps be of some interest in further elucidating the psychosomatic problems posed by this disorder.

Acknowledgements—Our thanks are due to Dr. R. S. BRUCE PEARSON for his help and advice, to the Governors of our joint hospitals for providing the copies of the Cornell Medical Index, and to Dr. H. M. BALFOUR for his help with the "normal controls."

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 137 to 143. Pergamon Press Ltd., London

THE DETERMINANTS OF THE RATE OF SPEECH OUTPUT AND THEIR MUTUAL RELATIONS

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1. INTRODUCTION AND PROBLEM

THE nature of speech production is such that only rarely is a continuous flow of verbal output achieved. In most cases speech utterances are series of verbal productions of different lengths which are broken up into discrete elements by halts and pauses of varying duration.

It is to be expected that these breaks in the flow of speech determine to some extent the speech rate in any utterance, if by speech rate we mean the rate at which a certain number of syllables is produced per unit of time. (In this investigation speech rate will be the number of syllables per second).

Speech rate calculated in this way was shown to possess a high degree of consistency for individuals, and sensitivity under the impact of changing conditions (GOLDMAN-EISLER, 1954a,b). As it seemed obvious that the fluctuations in the rate of speech output must, at least partly, be a function of the duration and of the frequency of the breaks in the stream of speech, a study of this aspect of speech output was undertaken.

The questions were:

(a) To what extent does the amount of pausing in the flow of speech determine speech rate and its fluctuations?

(b) What is the determining influence of the absolute speed of talking, i.e. the speed of actual articulation upon the overall rate of speech, or total speech rate?

(c) What are the internal relations of total or overall speech rate, articulation rate, and the length of halts and pauses in speech?

2. EXPERIMENT

In order to answer these questions, information about the following quantities was required:

(a) The number of syllables in each utterance $= Ns$ (utterances are periods of speech lasting from a preceding question or utterance of an interviewer to the next, which is usually occasioned by the subject having come to a natural stop or pause).

(b) The total duration of each utterance (in seconds) $= t$.

(c) The duration of halts and pauses occurring during each utterance $= tp$.

(d) The duration of periods of pure speech $= ts$.

From these quantities the following measures could be derived:

Ns/t = total or overall Speech Rate (SR).

Ns/ts = articulation rate (AR), or absolute speech rate.

$tp/t \times 100$ = percentage time, or proportional length of pauses (PP).

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These quantities were obtained from eight interviews which were recorded on a speech recorder. Apart from the microphone which fed the tape recorder, a throat microphone was fixed round the subject's neck to feed the speech movements into the same polygraph. Thus a record of electrical voice tracings was obtained. Another pen recorded seconds and half-minutes. A signal between each thirty seconds was fed into the tape recorder which coincided with the half-minute pen-mark.

The speech recordings were transcribed, the subjects' utterances timed, and the syllables in each utterance counted. In addition, the duration of pauses and halts

FIG. 1

within each utterance, which appeared on the voice-tracing line, were summed and subtracted from the total duration of the utterance to obtain the duration of the actual speech, and thus the absolute speech rate, or articulation rate. In Fig. 1 the kind of record underlying the investigation is illustrated.

Interviews were recorded from eight subjects; five of these were patients of the Maudsley Hospital, and three were members of the staff. The interviews lasted from thirty minutes to an hour, and contained between eleven and fifty-four utterances (Table 1).

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TABLE 1.—Means (*M*), Standard Deviations (*SD*), and Variation Coefficients ($SD/M \times 100$) or *V* of Speech Rates (*SR*), Percentage Time of Pauses (*PP*), and Articulation Rates (*AR*), for utterances from interviews with eight subjects.

	SR			*PP*			*AR*			Number of utterances
	M	*SD*	*V*	*M*	*SD*	*V*	*M*	*SD*	*V*	
S. I.	4·3	0·78	18·1	4·4	4·01	91·1	4·5	0·75	16·6	26
Co.	3·9	0·53	13·6	19·3	10·4	53·8	4·9	1·12	22·8	53
He.	3·7	0·44	11·8	27·9	18·2	65·2	5·0	1·03	20·6	11
S. II.	3·3	1·09	35·8	29·8	9·7	32·5	4·7	0·54	11·5	15
Jo.	3·3	0·93	28·2	34·3	12·5	36·4	5·0	0·69	13·3	29
Mu.	2·8	0·78	27·8	43·6	12·9	29·6	5·2	1·06	20·4	54
Pea.	2·7	0·45	16·6	53·2	15·0	28·2	5·9	1·48	25·1	46
B. I.	2·3	0·81	35·2	47·6	14·3	30·0	4·4	0·60	13·7	33

Standard Deviations (*SD*) and Coefficients of Variations (*V*) of Means for eight subjects

SR		*PP*		*AR*	
SD	*V*	*SD*	*V*	*SD*	*V*
0·71	21·5%	14·92	45·9%	0·45	9·1%

3. RESULTS

(a) *Relations between Individuals*

Table 1 lists the mean and standard deviations of each subject's speech rates (*SR*), relative duration of pauses (*PP*), and articulation rates (*AR*).

From these average values it may be seen that there is a close inverse relation between the proportional duration of halts and pauses (*PP*) in speech utterances and the total speech rate (*SR*). In other words, the longer and more frequent the pauses, the slower is the total rate of speech production. The rank correlation was −0·940. The absolute speech rate plays no significant part in the rate at which speech is produced over a period of time (rank coeff. $r_{SR/AR} = -0{\cdot}173$). This is in harmony with the result of an investigation by HENZE (1953), who found that the total time of utterances correlated with the time taken up by pauses was 0·730, while its correlation with the absolute speaking time was 0·207 (insignificant).

This seems not surprising if we compare the variability of the absolute speech rate with that of the pauses. As these two series of measurements are in two different units with greatly differing means, the variation coefficient ($SD/M \times 100$) was used to compare their relative dispersions. The variation of the mean percentage times of pauses (*PP*) and the mean articulation rates (*AR*) in the group of eight subjects can be expressed by the variation coefficients 45·9% ($M = 32{\cdot}5$, $SD = 14{\cdot}92$) for *PP*, and 9·1% ($M = 4{\cdot}95$, $SD = 0{\cdot}45$) for *AR*. The variation coefficient for the total speech rate (*SR*) was 21·5% ($M = 3{\cdot}3$, $SD = 0{\cdot}71$).

The articulation rate proved of remarkable invariance, not only when the means for the eight subjects were compared, but also within any one of these subjects. As the column of variation coefficients shows, the variability of absolute speech rates from utterance to utterance in any one subject as expressed by this index ranged from 11·5 to 25·1%, with a mean variation coefficient for all subjects of 18·0%, while that of the halts and pauses ranged between 28·2 and 91·1%, with a mean coefficient of variation of 45·9%. The difference in the degree of variability between the speed of articulation (or absolute speech rate) and the relative duration of breaks in the utterances (*PP*) is highly significant ($t = 3{\cdot}85$, $P =$ beyond 0·01).

The variability of the total speech rate for the different individuals was thus shown to be a function of the high degree of variability in the durations of halts and pauses in the speech performances to which these individuals were inclined.

(b) *Relations within Individuals*

The question of the relation of these three aspects of speech within any one person is still to be answered. Table 2 shows the correlation coefficients of *SR*, *PP*, and *AR* for the utterances made in eight interviews by eight different subjects. All correlations between *SR* and *PP* are negative, indicating that the proportion of time taken up by stops in the stream of speech production is generally responsible for the variations in the total rate of speech.

At the same time the degree of the relationship varies from person to person; and as one might expect after some reflection, it varies with the preferred length of time taken up by the halts and pauses in any one person's speech. This dependence is expressed in the correlation rank coefficient $r = 0{\cdot}786$ between the mean percentage of pausing-time in the total speaking-time of any person and their correlation coefficients between speech rate (*SR*) and proportional length of pauses (*PP*).

The overall speech rate is therefore a function of the relative duration of halts and pauses interrupting the flow of continuous speech, and the degree of association depends upon the proportion of time of utterances which is lost in halting and pausing.

From this one would expect that the more continuous speech is, the closer would be the association between the total and absolute speech rate. Indeed, with a perfectly continuous stream of talking, the two rates would be identical. This conclusion

TABLE 2.—Inter-correlation Table for Speech Rates (*SR*), Percentage Time of Pauses (*PP*). Articulation Rates (*AR*), and Respiration Rates (*RR*) for eight subjects.

	RR	*PP*		
S. I.		−0·018		
Co.		−0·225		
He.		−0·207		
S. II.		−0·695‡		
Jo.		−0·352*		
Mu.		−0·394†		
Pea.		−0·656‡		
B. I.		−0·155		
	SR			
S. I.		−0·201	0·278	
Co.		−0·297*	0·021	
He.		−0·867‡	0·326	
S. II.		−0·617†	0·309	
Jo.		−0·865‡	0·500†	
Mu.		−0·600‡	0·448‡	
Pea.		−0·999‡	0·645‡	
B. I.		−0·875‡	0·053	
	AR			
S. I.		0·063	0·378	0·915‡
Co.		0·547‡	−0·106	0·542‡
He.		0·069	−0·316	−0·378
S. II.		−0·239	0·300	0·119
Jo.		−0·384	0·471†	0·766‡
Mu.		−0·071	0·071	0·526‡
Pea.		0·567‡	−0·252	0·254
B. I.		−0·350	−0·256	0·592‡

*P = 0·05
†P = 0·01
‡P = 0·001

seems to be borne out when we look at the correlation between *SR* and *AR* (0·915) of subject S. I., the most fluent of our subjects, who paused only 4·4% of the talking-time. The rest of the correlation coefficients between *SR* and *AR*, however, show a varying and, as may be seen from Table 2, in four cases highly significant degree of association.

The insignificant correlation coefficients as obtained above (−0·173) and by HENZE (1953) (0·209) were between the overall means of total and absolute speech rate derived for any one subject, and they appear to have masked great differences between individuals of the function of articulation rate in speeding up or retarding the overall rate of speech output. These differences can, however, not be accounted for in terms of preferred lengths of pauses. The rank r between the mean lengths of pauses and correlations of *SR* and *AR* were insignificant (0·190).

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It thus seems that while in the event of great fluency, when pauses are negligible, the overall speech rate (*SR*) and the rate of articulation (*AR*) measure practically the same thing, as is the case with S. I.; in the event of pauses taking up any appreciable amount of time, the rate of articulation ceases to be the only determinant of the overall speech rate. And while the dependence of the total speech rate *SR* on *PP* increases as the percentage of pausing-time (*PP*) becomes greater, the influence of the rate of articulation (*AR*) not only lessens but also becomes more indeterminate.

This may be due to the high degree of invariance of *AR* as compared with the high variability of *PP*, and the different ways in which the absolute speech rate (*AR*) combines with the lengths of pauses. From Table 2 we may see that in some persons long pauses tended to be associated with bursts of fast speech interspersed (Co. 0·547, Pea. 0·567) while in others there was a slight, though statistically insignificant, tendency to combine slow speech and long pauses or fast speech and short pauses (S. II. —0·239, Jo. —0·384, B. I. —0·350). In three subjects, the two quantities were unrelated (S. I. 0·063, He. 0·069, Mu. —0·071). The different ways in which the absolute speed of speech production combines with the length of intermittent pauses may help to discriminate different significances in the changes of the total speech rate. It is interesting to see that even where there is some inverse relationship between the lengths of pauses and the rate of articulation, it is insignificant. This seems to indicate that the variations of fluency in the production of speech which manifest themselves so clearly in the lengths of halts and pauses have, with these subjects, little impact upon the actual rate of the speech movements (*AR*) themselves. *AR* maintains a remarkable constancy under the conditions of high variability of pauses. *In other words, facilitation and inhibition in the output of speech show their effect more in the pauses* between *the speech movements than in any changes of the rates of these movements themselves.*

The only two significant correlations between the length of pauses and the absolute rate of speech (*AR*) (Co. 0·547 and Pea. 0·567) are coincident with the highest degree of variation (*SD's* of 1·12 and 1·48) in the rate of articulation (*AR*) in the group investigated. In these cases increased fluency of the speech movements themselves is accompanied by decreased fluency in the continuity of the speech flow, and vice versa. It would seem, in fact, that the one is conditional upon the other in the sense that speech production has in these cases been facilitated as a result of some process taking place during the extended pauses. In other words, the pauses preceding bursts of speech of high fluency may be assumed to be not pauses of inactivity, blocking, or inhibition, but of a nature preparatory to speech. Activities such as thinking, inner speech, or diction in the sense used by KAINZ (1954), i.e. verbal formulation of thought content, might fittingly be interpolated into these stoppages. And it might well be that the type of correlation we get between length of pauses and rate of absolute speech is a pointer discriminating between the halts and pauses in which the movements of actual articulation are prepared, and between such as are due to inhibition and emotional blocking. At the same time, the former condition, i.e. the alternation of long stops and fast speech, need not necessarily be imagined as of always reflective nature. It is conceivable that apart from the cognitive tension between thinking, "diction," or verbal formulation on the one hand, and articulation on the other, the above-mentioned alternation might reflect the oscillation between inhibitory forces such as resistance, and active drives towards communication. Thus

the positive correlation between length of pauses and speed of articulation would indicate tension either of a cognitive nature such as between reflective and articulatory activity, or emotional tension between the tendencies towards withholding and those towards communicating material. Where the speed of articulation remained unaffected by the variations in the length of halts and pauses in speech, and even more so where it tends to decrease with their lengthening, a general inactivity, inhibition, or apathy would seem to pervade the slowing tempo of speech production all through. This problem calls for further investigation.

4. THE RELATION BETWEEN THE DURATION OF PAUSES AND THE FREQUENCY OF BREATHING IN SPEECH UTTERANCES

Some light may be shed upon the psychological significance of halts and pauses by relating them to breathing during speech. There is a good deal of evidence (GOLDMAN-EISLER, 1955) to show that restricted breathing is associated with states of attention, inhibition, or fear. Previous work by the author (1956) confirmed that this relationship held during speech, showing that restricted breathing had been associated with topics of restricted emotionality (fear, inhibition, caution, and reasoning) and high breathing activity accompanied outgoing effects such as jealousy, food, sex, aggression, and wishes.

It may be argued that, if pauses increase with an increase of inhibition or reflection, breathing activity (respiration rate) should become more restricted as pauses become longer. Respiration rates were calculated by counting the inspirations—which are clearly audible on good-quality recordings—in each utterance, and dividing their number by the duration, in minutes, of the utterance. *RR* is therefore the number of breaths per minute of utterance.

Table 2 shows that for the eight subjects the correlation coefficients, though on the low side, are consistently negative. Four of these correlations are significant, three beyond $P = 0{\cdot}01$. Again, the correlation is lowest for the subject with the least proportion of halts and pauses in her utterances.

The intercorrelations between speech rates (*SR*), time spent on pausing (*PP*), and respiration rates (*RR*) thus point to what seems to be an inhibition-excitation syndrome. *This syndrome, while measureable through the process of speaking, is characterized by the fact that it manifests itself not in the* activity *of speaking, but in the delays breaking up the continuity of the speech performance, as well as in the delays interrupting the respiratory rhythm.*

5. SUMMARY

This investigation was undertaken to study to what extent interruptions in the flow of speech determine the speech rate in terms of speech output per time unit, and its fluctuations, and what was the determining influence of the speed of actual articulation. The data were obtained from recorded interviews of eight subjects.

The overall speech rate was shown to be largely determined by the duration and frequence of halts and pauses interrupting the stream of speech. The actual speed of talking as measured by the number of syllables per second of the period spent in pure speech (rate of articulation) had a bearing on the overall speech rate in some cases, but not in others.

There were also different ways in which the duration and frequency of halts combined with the variations in the rate of articulation. With some, as halts and pauses

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grew shorter articulation accelerated, indicating that the whole system was gaining in speed and fluency. With others there was no relation between pauses and rate of articulation. With others, again, articulation accelerated as pauses became longer.

A hypothesis, to be followed up by further investigation, was derived from these facts; that the positive correlation between the length of pauses and the speed of articulation might indicate tension, intellectual as well as emotional.

Measures of breath rate during speech were also related to the percentage time of pauses, and the correlations were consistently negative. There is thus a three-corner relationship of measures of speech production showing that the rate of speech output decreases as the halts and pauses increase and breathing becomes less frequent.

The implications of this relationship seem to point to an inhibition-excitation syndrome measurable during and through the speech process, and manifesting itself in the blocking of the activities of speech as well as of breathing rather than as changes in the activities themselves.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 144 to 146. Pergamon Press Ltd., London

A SIMPLE METHOD OF RECORDING RESPIRATION

BRIAN ACKNER, M.D.*

RECORDING respiration during psychosomatic investigations often presents many problems. In order that the technique of recording itself should not introduce an additional emotional factor, it is essential that apparatus, as well as being sensitive and accurate, should be simple to apply, unobtrusive, and nonrestrictive.

The spirometer is clearly unsuitable, for the mask or mouthpiece together with the nose-clamp can disturb the subject and, by drawing attention to the recording, often cause voluntary controlled respiration. The conventional pneumograph is cumbersome and the restriction during inspiration is noticeable by the subject. Techniques which involve the principle of cooling by the breath of electrically heated fine wire have the advantage of simplicity, but the disadvantage of requiring some device to support the wire near the nose.

In recent years there has been increasing use of electrical strain gauges for recording small linear changes of dimension. The mercury-in-rubber resistance strain gauge was described by WHITNEY (1949, 1953, 1954) for the purpose of measuring changes in limb girth, and later modified by WADE (1954) for recording respiratory movements. In this method the linear changes of a very small-bore rubber tube are derived from the changes in electrical resistance occurring in the fine mercury column which completely fills the bore of the tube. Stretching the tube lengthens and narrows the mercury column, with resulting increase in its electrical resistance. Mercury-filled tubes form the variable resistance in two limbs of a conventional bridge circuit, and changes in balance are amplified and suitably recorded.

The mercury-in-rubber strain gauge is a simple piece of apparatus, easy to apply, unobtrusive, very sensitive and requiring no complicated electronic amplification. Its construction, however, is accompanied by problems connected with the difficulty in filling completely the small bore of the rubber tube with mercury whilst avoiding an air bubble, and at the same time achieving a good electrical contact with an electrode not subject to interference by the action of the mercury. Previous authors have not described in detail their method of filling the rubber tube with mercury, and little mention is made of the difficulties which must have arisen with the type of electrode used. WHITNEY states that, after the tube is filled with mercury, the "ends of the tube are closed with tapered copper pins, the points being amalgamated before insertion in the tube to ensure good electrical contact between the end of the mercury thread and its respective pin." WADE states that the tubes "are filled with mercury and plugged with pins formed from the heads of brass bolts."

This communication describes a simple method of filling the rubber tubing with mercury so as to achieve a perfect electrical contact with the electrodes.

The rubber tubing used has a bore of 0·25 mm with a wall thickness of 1 mm. It is supplied in lengths of about 44 cm (Dunlop Special Products). For each strand of the strain gauge one length of tubing 40 cm long and two lengths about 10 cm long are

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used. The electrodes are constructed from stainless steel hypodermic needles of 0·7 mm size (B.W.G. 22). The collar of the needle is sawn off and both ends are filed to give a smooth surface. The conducting wire is then soldered on to the middle of the needle. Two such electrodes are prepared and inserted to a third of their length into

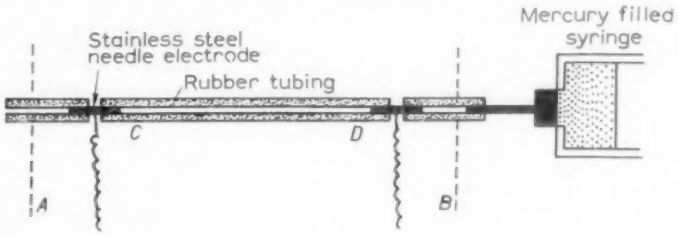

FIG. 1.

either end of the bore of the larger length of rubber tubing. The exposed end of each electrode is then inserted into the bore of the smaller length of rubber tubing. A hypodermic syringe is filled with mercury and the needle inserted into the bore of the rubber tubing as shown in Fig. 1. No difficulty is experienced in forcing the mercury through the tubing and, when it is flowing freely, artery forceps are applied to the distal end of the tubing at *A* (Fig. 1). Slight positive pressure is applied

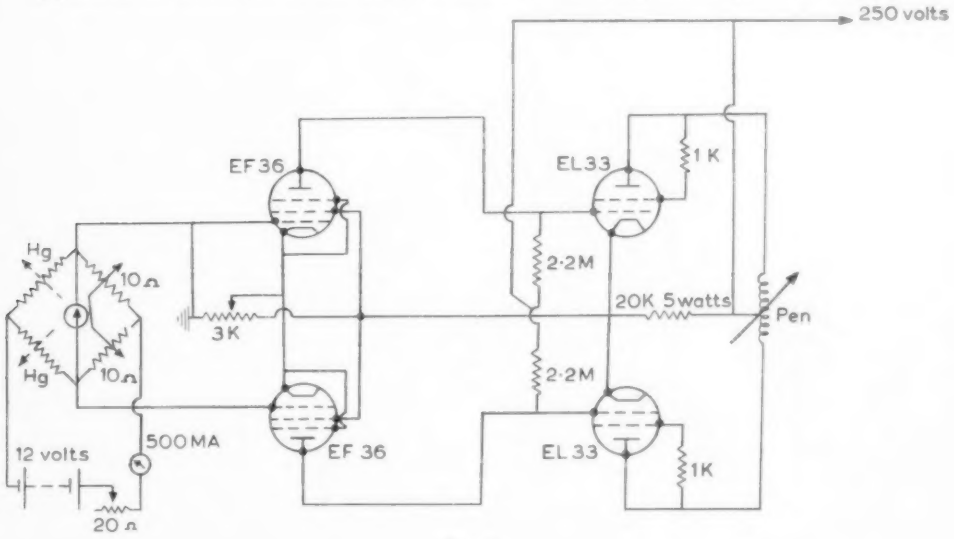

FIG. 2.

to the syringe and then artery forceps are applied to the tubing a short distance beyond the needle point at *B* (Fig. 1). The syringe and needle are then removed, the rubber tubing is tied in a knot on the inner side of each artery forceps, and the latter are then unclipped. The gauge is thus completely filled with mercury and a perfect electrical contact is achieved as a result of the mercury flowing within the hollow stainless-steel electrodes. The latter are firmly secured to the rubber tubing by the application of Bostick. The latter compound is also used to attach tapes to the tubing at *C* and *D* (Fig. 1), and these are used to tie the gauge horizontally around the chest.

Each tube so constructed has an electrical resistance of some 2–3 ohms (4–5 ohms when stretched around the chest), and an average respiratory excursion causes a resistance change of about 0·25 ohms. The actual gauge consists of two such mercury-in-rubber tubes forming two limbs in a bridge circuit of which the two opposing limbs (of approximately the same resistance as the mercury tubes) are ganged. The bridge circuit is conveniently fed by a 12-volt battery, and its sensitivity is controlled by a variable resister in series with the bridge and monitored by a meter. After the rubber tubes have been stretched round the chest and tied behind the back, the bridge circuit is balanced. The subsequent changes in balance caused by the respiratory movements are amplified and fed to a suitable recording pen (Fig. 2).

Because of its elastic properties, the rubber tubing does not restrict the respiratory movements and it is hardly noticeable by the subject. The sensitivity of the gauge is such that the slightest respiratory movement is immediately registered. The tracings obtained are a faithful representation of respiratory rate and rhythm. However, as the sensitivity of gauge will vary with its initial length, more complicated treatment is required for accurate measurement of changes in respiratory amplitude.

The whole operation of construction of the gauge takes some fifteen minutes and it can remain serviceable for months.

Acknowledgements—I am indebted to Mr. W. A. GURNHILL for technical assistance, and to the research committee of the Board of Governors of Bethlem Royal and the Maudsley Hospitals for financial support.

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LIFE SITUATIONS, BEHAVIOUR, ATTITUDES, EMOTIONS AND RENAL EXCRETION OF FLUID AND ELECTROLYTES*—II†

RETENTION OF WATER AND SODIUM; DIURESIS OF WATER

W. W. SCHOTTSTAEDT, M.D.,‡ W. J. GRACE, M.D., and H. G. WOLFF, M.D.

EARLY in this century variations in urine volume induced by hypnosis and during conditioned reflex experiments were recorded (DUNBAR, 1946). MACKEITH and his co-workers (1924) observed that situations that engendered the maintenance of the tense attitude preparatory to running a race were associated with inhibition of urine output similar to that seen accompanying running itself. RYDIN and VERNEY (1938) also observed that "exercise" was associated with such inhibition. They concluded that the antidiuresis of "mild exercise" was an accompaniment of the stress experienced when the exercise was begun. They demonstrated persistence of the antidiuretic response after renal denervation and a similar inhibition following injection of posterior pituitary extract. O'CONNOR and VERNEY (1946) later demonstrated two mechanisms for the antidiuresis which accompanied stress in their experiments: (1) secretion of antidiuretic hormone accompanied by prolonged inhibition of urine flow, and (2) sympathetic stimulation or secretion of adrenalin accompanied by a transitory inhibition of urine flow. BROD and SIROTA (1949) demonstrated a decrease in renal blood-flow and in glomerular filtration rate, as measured by PAH and creatinine, in rabbits during "emotional disturbance" and noxious stimulation. BLAKE (1951) has reported a decrease in sodium excretion in dogs in association with exercise and "emotion" with no change in glomerular filtration rate.

In their studies on normal and diabetic humans, HINKLE, EDWARDS, and WOLF (1951) have described a diuresis occurring in association with stressful situations which aroused feelings of "anxiety." And recently MILES, DE WARDENER, and MCSWINEY (1952) have reported a striking diuresis in association with an emotional reaction to cystoscopy occurring in a hypertensive woman. The present studies on healthy individuals were undertaken to define specific situations with behaviour and emotional responses associated respectively with decreased and increased urine flow.

METHOD

Two types of studies have been performed:

(1) A series of long-term observations, covering periods of fourteen to forty-six days, have been made on five healthy individuals while they were engaged in their usual daily work and responsibilities. Details of this type of study have been reported (SCHOTTSTAEDT *et al.*, 1956).

* From the Department of Medicine of the New York Hospital and Cornell University Medical College. This study was made possible in part by grants from the Commonwealth Fund and the U.S. Public Health Service.

† Part II represents the second of a series of five papers which are being published consecutively.

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(2) In addition, a series of short-term observations were made on a group of subjects studied for periods of two to four hours under constant, defined conditions: during the morning hours, in a uniform laboratory setting, sitting throughout, and following overnight abstinence from both food and fluid. After a period of baseline observations, interviews were conducted during which pleasant and diverting topics or highly significant topics known to be capable of eliciting strong emotional responses were discussed. The behaviour, attitudes, emotions, and feeling states were evaluated by both subject and observer, the observer relying on the nature of the subject's utterances, intonation, facial expression, bodily movements, and blushing, blanching, blood pressure, and pulse rate. Urine specimens were collected at hourly intervals, and rates of excretion of water, sodium, and potassium were determined for periods before, during, and after each interview. Sodium and potassium determinations were made in duplicate, using a Barclay flame photometer (FOX, 1951).

Emotions and feeling states were evaluated by the subjects themselves in the long-term experiments and by both subject and observer in the short-term experiments where continuous observation was possible. When clearcut, the differentiation of emotions, such as anger, fear, or depression, is easily made by most individuals. Differentiation of feeling states sometimes offers considerable difficulty, but individuals can learn to make certain gross distinctions with fair reliability. Thus, when approaching an examination, an individual may feel confident of his knowledge and ability and certain that he will perform adequately if he is "on his toes." At such times he may be aware of muscular tension; but he refers to this feeling state as "tension" even when unaware of any muscular reaction. Such a grouping of situation, behaviour, attitude, and feeling state constitutes pattern A in this paper. The same individual may, on the other hand, approach an examination uncertain of his knowledge and ability, and fearful lest he fail. At such times he will describe his feeling state as "apprehension," "anxiety," or "uneasiness." This grouping constitutes pattern B of the present reports. The situations may appear very similar to an observer, but an important part of the situation is the individual's evaluation of his capacity to meet it. This is very different in the two instances given. Under many circumstances, an individual will approach an examination with mixed feelings of confidence that he can do well if everything proceeds smoothly, but fearful lest unforeseen difficulties arise. At such times he may be unable to state which pattern of reaction is predominant, and the period is then considered to be a combination of patterns A and B in the present investigations.

The broad categories of emotions and feeling states referred to in these papers were discussed in advance with the subjects, so that the words used would have similar meanings for all subjects. No attempt was made at precise definition of differences in quality between one episode of apprehension, for example, and another. Gross differentiations were used, since these could be made with greater reliability. The subjects evaluated their feeling states throughout each day of the period of observation and kept a record of this. They had no information about the laboratory data. The records were read as they accumulated, and where the feeling state of the individual was not clear from the statements made, this was clarified before laboratory data was available. The evaluations made were not subsequently altered, and correlation of psychologic and physiologic data was made only when collection of both types of data was complete.

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Excretion rates for the long-term experiments represent means for a four- to six-hour period. Excretion rates for the short-term experiments represent means for one-hour periods of observation.

RESULTS

Long-term Observations

During periods in which Subject No. 1 was chiefly concerned with doing routine housework, was quietly sewing, or was reading while the children rested, urinary output averaged $0{\cdot}76 \pm 0{\cdot}17$ cm³/min. She generally described such periods as "tranquil" or "neutral" (Table 1). At other times increased demands in terms of work and responsibilities were made upon her, such as preparing for the entertainment of guests, caring not only for her own but her neighbours children, or meeting situations which interfered with the daily routine. She assumed responsibility seriously, was sensitive to opinions and feelings of others, and was orderly, organized, and "on time." Hence she faced such situations with feelings of alertness, increased readiness to respond, and with the knowledge that she could handle the situation despite the increased demands (pattern A). At such times, urine flow averaged $0{\cdot}54 \pm 0{\cdot}16$ cm³/min (Table 2). When she was visiting with her friends or having a brief respite from the care of the children following such periods of alert behaviour, urine flow averaged $1{\cdot}55 \pm 0{\cdot}39$ cm³/min (Table 3). She characterized such periods as "relaxation" and considered them diverting and pleasurable. Such periods of pleasurable relaxation following periods of tension have been classified in this paper as release or "freedom from tension," and for brevity referred to as pattern A′.

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These data have been summarized in Table 4, and the *t*-test has been applied to the differences in the means (Table 5). Both the decrease in urine volume in association with pattern A and the increase in urine volume in association with pattern A′ are significant at the 0·1 per cent level of confidence.

Comment: A considerable overlapping in ranges of excretion rates for neutral periods and for periods characterized by pattern A was noted. This is probably due to the difficulty in precise evaluation of these patterns and to the fact that the reactions were not entirely uniform throughout any five-hour period. The data indicate, however, that there is retention of water in association with behaviour indicating readiness to respond and with feelings of increased alertness; while, inversely, there is a diuresis in association with behaviour and feelings indicating "freedom from tension."

Rates of excretion of sodium are summarized in Table 4. In those periods considered predominantly neutral and tranquil for Subject No. 1, urine-sodium excretion averaged 96 ± 20 μeq/min. During periods of increased alertness and readiness to respond, sodium excretion averaged 61 ± 29 μeq/min. During periods associated with sudden "freedom from tension," or pleasurable relaxation, sodium excretion averaged 98 ± 30 uEq/min. The decrease in sodium excretion associated with situations evoking increased alertness and readiness to respond is significant at the 0·1 per cent level of confidence. The difference in mean rates of sodium excretion during periods of tranquillity and sudden "freedom from tension" is not significant.

Rates of excretion of potassium are also summarized in Table 4. Night and daytime excretion rates have been given separately because of the marked nocturnal decrease in potassium excretion. The small differences recorded in potassium excretion during neutral periods and periods associated with pattern A or pattern A′ are not significant (Table 5).

TABLE 1.—RENAL EXCRETION IN ASSOCIATION WITH SITUATIONS EVALUATED AS NEUTRAL AND TRANQUIL

Subject	Time	Situation	5-hour excretion of H_2O cm^3/min	Na $\mu eq/min$	K $\mu eq/min$	5-hour intake of H_2O cm^3	Na meq	K meq
No. 1	a.m.	Peaceful a.m. sewing and visiting	1·01	110	42	300	19	11
		Routine housework and child-care	1·09	130	59	300	11	5
		Routine housework; wrote a letter	0·67	101	40	300	11	5
		Washing, sewing, and shopping	1·05	69	68	300	15	5
		House-cleaning and laundry	0·93	94	50	300	15	5
		Housework and walk with children	1·00	67	74	300	17	9
		Shopping for wedding gift	0·57	75	39	300	19	6
		Housecleaning	1·08	81	64	450	13	6
		Routine housework	0·88	97	57	450	13	8
		Laundry, sewing, and child-care	0·66	83	65	350	7	17
		Shopping and large laundry	0·81	98	62	315	11	4
	aft.	Tending children	1·13	133	61	300	0	0
		Dishes, ironing, nap, and swim	0·74	139	48	300	34	4
		Pleasant day with children	0·54	83	41	550	21	18
		Routine housework	0·55	88	38	550	21	18
		Tending children, uneventful	0·63	96	63	1200	43	28
		Nap and child-care	0·63	103	49	200	31	4
		Housework and child-care	0·61	57	49	300	4	7
		Slept two hours. Brother visited	0·77	83	50	300	47	20
		Visiting and ironing	0·91	115	70	650	67	18
		Resting and reading	0·86	73	51	450	20	16
		Ironing and shopping	0·70	97	77	450	39	20
		Laundry, and ride with children	0·58	106	61	500	48	28
	evg.	Visiting with friends	0·89	88	28	450	113	19
		Sewing and housecleaning	0·82	71	46	300	71	20
		Visiting with friends	0·59	115	41	1290	117	38
		Dining out	0·74	105	94	490	83	29
		Evening out with friends	0·51	84	37	1125	104	37
		Large family gathering	0·98	115	38	490	83	34
		Evening out with neighbours	0·63	100	37	875	37	43
		Short walk, and to bed early	0·55	74	68	1000	85	57
		Cleaning and moving furniture	0·63	62	62	450	37	17
		Quiet evening at home	0·58	75	34	1100	76	39
		Visit with relatives	0·58	121	50	550	48	35
		Quiet evening	0·59	88	36	550	139	37
		Quiet evening	0·80	94	70	750	46	39
	night	Quiet night; slept well	0·96	111	11	300	7	2
		Quiet night	0·63	113	23	0	0	0
		Quiet night	0·98	95	14	250	0	0
		Quiet night after tense evening	0·68	133	18	0	0	0
		Quiet night	0·62	79	18	0	0	0
		Quiet night	1·03	75	37	0	0	0
		Quiet night	0·74	88	23	0	0	0
		Quiet night	0·87	91	25	0	0	0
		Quiet night	0·62	136	30	0	0	0
		Quiet night	0·74	111	29	250	0	0
		Quiet night	0·53	121	28	0	0	0
No. 2	a.m.	Doing experimental work	0·89	95	78	240	0	0
		Seeing patients in clinic	0·74	115	62	500	13	12
		Discussing work with colleague	0·62	88	58	640	39	17
		Reading in library	0·67	124	62	700	40	19
		Quiet morning at work	0·68	121	71	600	21	10
	aft.	Seeing patients in clinic	0·54	99	40	640	81	30
		Doing laboratory work	0·60	103	45	640	43	20
		Discussion with colleague. Patients	0·86	104	49	640	73	23
		Desk work	0·42	88	47	1270	78	45
		Routine work	0·86	121	57	920	43	30
		Interviewing patients. Desk work	0·55	97	57	1070	67	28
		Warm Sunday afternoon with children	0·58	89	44	1100	63	60
		Desk work	0·74	127	52	1070	21	12
		Interviewing patients. Desk work	0·97	66	28	1080	39	21

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TABLE 1 (*continued*)

Subject	Time	Situation	5-hour excretion of H_2O cm³/min	Na μeq/min	K μeq/min	5-hour intake of H_2O cm³	Na meq	K meq
		Sunday at home with children	0·86	121	57	800	36	52
	evg.	Attended discussion club	0·61	107	46	640	42	31
		Laboratory work	0·54	82	45	640	28	37
		Quiet evening reading Santayana	0·66	131	66	1100	90	45
		Quiet evening at home	0·68	119	67	1350	70	29
		Working on data	0·61	99	43	1400	65	38
		Visiting with friends	0·68	104	51	750	9	15
		Quiet evening at home	0·65	110	81	1030	28	21
		Reading journals	0·64	120	85	900	29	29
		Evening with friends	0·80	86	60	1370	47	21
	night	To bed tired	0·52	58	41	0	0	0
		Slept well	0·74	81	25	0	0	0
		Slept well after quiet evening	0·53	97	29	0	0	0
		Sleeping soundly	0·75	87	23	0	0	0
		Slept well	0·65	61	33	0	0	0
		Slept well after quiet evening	0·62	67	28	0	0	0
		Slept well	0·50	73	33	0	0	0
		Slept well; awakened early	0·65	74	25	500	7	12
No. 3	a.m.	Quiet. Attended Mass	0·79	94	43	Data incomplete		
		Uneventful morning	0·70	97	46			
	aft.	With friend; ironing clothes	1·00	112	38			
		Routine office work	1·05	88	31			
		Watching parade from office	0·91	65	43			
		Routine work	0·66	62	35			
		Visit to museum	0·67	85	18			
		Quiet afternoon	0·64	85	60			
	evg.	With friend	1·00	112	38			
	night	Slept well	0·96	103	22			
		Fell asleep while reading	0·63	80	18			
		Fell asleep while reading	0·77	47	22			
		Slept well	1·00	73	28			
No. 4	a.m.	Routine activities	0·63	105	79	200	29	6
		Fairly quiet morning	0·75	117	80	200	29	6
		Routine activities	0·74	89	58	200	17	5
	aft.	Routine duties in clinic	0·50	109	60	240	47	5
		Relatively quiet afternoon	0·83	55	38	240	53	20
	evg.	Quiet evening. Tired	0·48	76	50	630	60	11
		Restful evening	0·71	129	83	440	51	30
	night	Quiet night	0·56	116	40	—	—	—
		Quiet night	0·81	112	29	360	22	15
		Quiet night	0·52	111	36	600	22	15
		Quiet night	0·84	84	51	480	19	11
		Quiet night	0·81	93	37	240	0	0
		Quiet night, but tired	0·56	74	34	240	5	9
		Quiet night	0·80	107	28	0	0	0
		Quiet night	0·76	100	24	240	5	9
		Slept soundly	0·69	117	37	480	8	13
No. 5	a.m.	Sleeping	1·39	274	102	0	0	0
		Quiet morning at work	1·11	221	65	800	99	12
	aft.	Quiet and relaxed, but working	1·17	258	53	330	79	14
		Uneventful afternoon	1·17	239	57	500	87	14
		Quiet afternoon	1·35	263	95	490	109	46
	evg.	Quiet evening	1·09	213	94	580	60	45
		Quiet evening	1·15	239	94	520	205	37
		Quiet evening	0·96	209	82	480	101	48
	night	Refreshing, dreamless sleep	1·39	257	80	450	33	17
		Sound sleep	1·13	261	28	250	102	14
		Quiet night	1·13	274	39	360	40	3

TABLE 2.—RENAL EXCRETION OF WATER, SODIUM, AND POTASSIUM IN ASSOCIATION WITH PATTERN A

Subject	Time	Situation	5-hour excretion of H_2O cm^3/min	Na μeq/min	K μeq/min	5-hour intake of H_2O cm^3	Na meq	K meq
No. 1	a.m.	Housework; children over-active	0·71	33	56	300	11	5
		With five children at zoo	0·27	16	31	300	7	6
		Housework; hectic a.m. with children	0·46	34	19	300	4	3
		Child hurt at play	0·58	56	28	300	45	12
		Countless interruptions of routine	0·82	84	45	300	7	6
		Too much to do	0·94	70	56	300	11	5
		Driving in heavy traffic	0·50	108	18	250	0	1
		Week-end shopping	0·41	55	39	300	21	6
		Troubles with laundry	0·36	24	57	300	7	3
		Child ill and demanding	0·48	61	49	190	10	5
		Preparing for company	0·51	56	73	300	25	6
		Children misbehaving	0·87	53	63	300	11	4
		Tending five children on playground	0·53	32	23	300	19	5
	aft.	Took driving test	0·82	60	50	900	97	53
		Drive in heavy traffic	0·37	39	71	550	43	22
		Much to be done; tired	0·46	72	62	250	60	14
		Children demanding	0·69	80	60	450	80	24
		Touring New York City	0·43	33	85	600	105	38
		Many things to be done	0·33	37	47	150	47	7
		Afternoon lunch for twenty	0·65	50	56	200	80	20
		Child-care	0·62	41	49	1040	54	27
		Children misbehaving	0·54	98	67	550	48	35
		Children difficult to handle	0·38	23	63	350	46	17
	evg.	Took neighbour to hospital	0·58	84	58	900	76	36
		"Tense" visit with relatives	0·68	101	68	1250	46	22
		Visiting friend in hospital	0·48	109	40	600	57	37
		Political discussion with friends	0·38	63	16	1075	69	35
		Helping with wedding rehearsal	0·61	104	67	1050	135	80
		Children over-active	0·58	57	39	750	127	49
		Constant interruptions of work	0·58	89	44	450	80	19
		Watching family movies	0·61	68	46	775	45	63
		Guests in for evening	0·58	53	77	300	11	15
	night	Close friend in labour	0·31	27	23	0	0	0
		"Tense" on retiring and awakening	0·46	94	20	0	0	0
No. 2	a.m.	Difficult morning in clinic	0·59	87	46	400	37	16
		Working on experimental data	0·51	70	33	600	26	15
	aft.	Constant interruptions in routine	0·35	56	40	420	78	22
		Extra duties imposed	0·40	81	49	420	57	30
		Difficult psychiatric patients	0·60	91	22	970	53	21
	evg.	Doing laboratory work	0·57	49	39	640	40	27
		"Tense and tired" after hard day	0·40	45	46	1000	46	66
		Forcing self to work though tired	0·60	72	56	1200	39	42
	night	Awakened repeatedly by children	0·48	61	27	0	0	0
		Sleeping after "tense" day	0·64	92	34	200	0	1
		Sleeping after "tense" day	0·73	89	26	0	0	0
No. 3	a.m.	Waiting for landlord after fight	0·66	79	16	Data incomplete		
		Searching information in library	0·45	52	34			
		Working in office	0·59	56	51			
	aft.	Talking with landlord	0·66	79	16			
	evg.	Refused to see boy friend	0·63	83	16			
		Accusing boy friend of lying	0·93	71	14			
		Waiting; boy friend did not arrive	1·09	54	22			
		Meeting of book club	0·61	30	11			
		Dinner with friend	0·76	48	14			
		Resting after trying day	0·59	47	24			

TABLE 2 (*continued*)

Subject	Time	Situation	5-hour excretion of H_2O cm^3/min	Na μeq/min	K μeq/min	5-hour intake of H_2O cm^3	Na meq	K meq
	night	"Tense" after talk with boy friend	0·93	71	14			
		Sleeping after difficult day	0·59	47	24			
		Boy friend had not arrived	0·35	38	16			
		After meeting of club	0·61	30	11			
No. 4	a.m.	Wife and child ill	0·44	43	51	440	18	6
		Trying unsuccessfully to reach M.D.	0·24	14	40	200	1	7
		Running household	0·45	33	55	200	18	6
		Constant interruptions in work	0·48	46	66	200	29	6
		"Tense"; many difficulties	0·52	74	58	200	18	6
		Too much to be done	0·31	34	37	200	18	6
		Active morning in clinic	0·51	63	43	200	29	6
		Very busy work-day	0·54	71	56	320	41	9
		"Tense" at work	0·55	103	57	500	43	20
	aft.	Entire family ill	0·40	27	64	300	57	12
		Too many things to do	0·31	34	37	240	70	9
		"Very tense"; much to do	0·38	44	40	600	43	25
		Very busy afternoon	0·64	90	60	240	67	21
		"Very tense" at work	0·37	31	47	240	46	13
		Very busy afternoon	0·46	70	69	0	0	0
	evg.	Entire family ill; many demands	0·50	57	53	120	52	10
		Many demands to meet	0·40	48	65	580	64	28
		End of a full, demanding day	0·46	64	48	540	59	32
		"Tense and tired" after day in clinic	0·44	98	50	390	90	21
	night	"Tense and tired" after busy day	0·57	57	36	480	19	11
		Family ill; unable to let down	0·35	58	37	480	14	14
		Tense on retiring and awakening	0·59	78	35	240	19	11
		Tired after working under pressure	0·48	76	28	0	0	0
		Worn out by difficulties of day	0·49	83	35	0	0	0
No. 5	a.m.	Working; muscles stiff	0·85	154	64	600	66	19
		Preparing speech	0·60	103	40	520	39	11
	aft.	Long drive before delivering speech	0·94	198	67	460	146	41
		"Very tense" performing experiment	0·60	109	51	450	22	18
		Doing work of two people	0·94	194	66	580	35	26
		Working to make deadline	1·01	232	50	400	88	25
	evg.	Delivered speech	0·69	115	89	690	102	34
		Working on experimental data	0·63	117	66	420	86	6
		Preparing report of work done	0·47	84	59	0	0	0
		"Tense" evening with friends	0·67	109	58	480	55	18
	night	Worked late; tense on retiring	1·10	158	36	480	49	9

Subject No. 2 was a healthy 35-year-old male physician who was studied for nineteen days. Renal excretory rates for water, sodium, and potassium were similar to those observed in Subject No. 1, and are given in Tables 1, 2, and 3. Periods during which his clinical work was proceeding quietly and according to schedule, evenings spent reading or charting data, and nights of quiet sleep were considered "neutral" and "tranquil." When the clinic hours were spent with difficult patients or when his schedule was overloaded, he responded with feelings of increased alertness; he felt "keyed up," in a hurry, and was pushing himself to complete his tasks with his usual amount of attention but in a shorter period of time (pattern A). Only twice during the entire period of observation did this subject experience the feeling of being free from responsibilities and problems (pattern A′). Weight records on this subject showed a

TABLE 3.—RENAL EXCRETION OF WATER, SODIUM, AND POTASSIUM IN ASSOCIATION WITH PATTERN A′

Subject	Time	Situation	5-hour excretion of H_2O cm^3/min	Na μeq/min	K μeq/min	5-hour intake of H_2O cm^3	Na meq	K meq
No. 1	a.m.	Relaxing after disturbed night	1·48	79	82	300	24	12
		Visiting; previous day "tense"	1·86	124	70	575	12	11
		Visiting after wedding over	1·30	65	55	350	11	9
		Pleasant shopping trip	1·57	105	74	300	29	8
		Breakfast with friends; previous day very full	2·00	94	40	450	22	6
		In bed; previous day very tiring	1·50	119	67	300	30	7
		Visiting after departure of guests	1·25	123	45	450	17	6
		Letter-writing; general house-cleaning previous day	1·36	107	48	300	18	6
		Work done; relaxing before wedding	2·14	80	53	525	31	12
		Enjoying tour of "Queen Mary"	1·33	74	63	300	11	10
	aft.	Long nap; up with children most of preceding night	1·19	91	48	650	51	27
		Visiting; previous day very full	1·31	74	81	600	105	38
		Resting after house-cleaning	1·74	96	51	300	70	21
		In bed resting from previous day	2·77	177	61	800	54	27
		Let down; child screaming with herpes in a.m.	1·37	64	47	450	28	18
		Letter-writing after house-cleaning	1·65	42	35	300	21	16
		Relaxing after housework done	1·30	66	47	250	15	10
		Visiting after housework done	1·26	74	54	525	74	44
		Alone after difficult a.m. with children	2·13	93	90	300	20	18
	evg.	Visiting relatives after hard day	1·08	87	28	850	113	29
		Relaxed evening	1·23	126	50	900	51	68
	night	Awakened feeling "refreshed"	0·85	100	40	0	0	0
		Relaxed after difficult day with children	1·19	118	36	0	0	0
No. 2	night	Resting after day of concentration	1·02	69	39	0	0	0
		Relaxing after "tense" week	1·69	67	52	0	0	0
No. 3	a.m.	Window-shopping	2·21	112	50	Data incomplete		
		Home from work	2·07	48	31			
	aft.	Visiting after disturbing week	2·97	101	15			
	evg.	Pleasant evening with boy-friend	1·26	49	15			
		Slept all evening, after routine day in office	3·33	71	27			
No. 4		None						
No. 5		None						

2–3 lb weight-gain during periods associated with pattern A, with loss of this weight accompanying the two diureses associated with pattern A′.

Subject No. 3 was a 26-year-old woman research worker who was studied for sixteen days. She had been referred for study because of uncontrollable attacks of rage which allegedly occurred at the time of her menses. Studies showed no predictable correlation of rage attacks to menstrual cycle and no significant fluid retention prior to or in association with menstruation. Periods during which her office routine was light or while she was quietly engaged in housework were considered by her to be "neutral" and "tranquil." When the office work-load was particularly heavy, she experienced feelings of being challenged, "on the spot," and under pressure to put out more work. She responded with increased alertness, greater speed, more movement,

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TABLE 4.—CORRELATION OF RATES OF EXCRETION WITH PATTERNS OF BEHAVIOUR, ATTITUDES, AND FEELING STATES

Subject	State	No. of obs.	Volume cc/min Mean	Volume cc/min S.D.	Urine Sodium Mean	Urine Sodium S.D.	Urine potassium Day No. of obs.	Urine potassium Day Mean	Urine potassium Day S.D.	Urine potassium Night No. of obs.	Urine potassium Night Mean	Urine potassium Night S.D.
No. 1	Pattern A	34	0·54	±0·16	61	±29	32	50	±18	2	21	—
	Neutral	47	0·76	±0·17	96	±20	36	54	±5	11	23	±8
	Pattern A′	23	1·55	±0·39	98	±30	23	59	±17	0	—	—
No. 2	Pattern A	11	0·52	±0·11	68	±16	11	44	±12	0	—	—
	Neutral	32	0·67	±0·13	97	±20	24	56	±14	8	29	±6
	Pattern A′	2	1·35	—	68	—	0	—	—	2	45	—
No. 3	Pattern A	14	0·66	±0·17	55	±18	10	23	±13	4	18	±6
	Neutral	13	0·83	±0·16	85	±18	9	37	±12	4	23	±4
	Pattern A′	5	2·37	±0·81	76	±29	5	27	±14	0	—	—
No. 4	Pattern A	24	0·46	±0·09	60	±23	19	54	±10	5	34	±4
	Neutral	16	0·69	±0·13	100	±20	8	60	±18	8	35	±8
	Pattern A′	0	—	—	—	—	0	—	—	0	—	—
No. 5	Pattern A	11	0·77	±0·20	143	±48	10	61	±11	1	36	—
	Neutral	11	1·18	±0·14	246	±23	8	80	±19	3	49	—
	Pattern A′	0	—	—	—	—	0	—	—	0	—	—

and sustained effort (pattern A). Pattern A′ included those collection periods during which she felt relaxed, cheerful, calm, and enjoying herself, such as when she was window-shopping or visiting with friends, when these feelings and activities followed periods of alert, sustained effort.

Subject No. 4 was a 30-year-old male physician studied for eighteen days. During the observation period his wife and family of four children became ill with an acute infectious disease. He was called upon to be at home about half of the working day, performing household chores, preparing meals, tending to the four sick children, and assuming responsibility for other treatment. Approximately half of the day was spent at the hospital, trying to perform all of his usual work and prepare a manuscript. He was pushing himself, doing many tasks, meeting many unexpected demands, participating actively in all of these, and alert to the possibility of more. Often during this time he felt "just able to cope," and "hanging on." There were also feelings of resentment at the interference with his work. Overall, however, the predominant feeling was one of alertness, readiness to participate, and striving (pattern A).

Subject No. 5 was studied for fourteen days. His food and fluid intake were considerably higher than for any of the other individuals studied, and his excretion rates reflect this high intake. Though all excretion rates are higher in this subject because of the increased food and fluid intake, the pattern of excretion is the same as in the other subjects.

In all five subjects, a decrease in urine volume and in rate of sodium excretion was observed in association with situations arousing alert behaviour, readiness to respond, and feelings of "tension." In the three subjects who had periods of relaxation and a sense of freedom from cares following such periods of alert behaviour, there was a diuresis of water unaccompanied by any diuresis of sodium.

Variations in excretion during muscular activity and recumbency—In a previous

TABLE 5.—SIGNIFICANCE OF DIFFERENCES IN EXCRETION RATES OBSERVED WITH VARIOUS PATTERNS OF BEHAVIOUR, ATTITUDES, AND FEELING STATES

States	Subject	H_2O No. of obs.	H_2O Diff. of means	H_2O P	Na No. of obs.	Na Diff. of means	Na P	K No. of obs.	K Diff. of means	K P
Neutral and pattern A	No. 1	81	22	*0·001*	81	35	*0·001*	68	4	*N.S.*
	No. 2	43	15	*0·005*	43	29	*0·001*	35	12	*0·025*
	No. 3	27	17	*0·025*	27	30	*0·001*	8	5	*N.S.*
	No. 4	40	23	*0·001*	40	40	*0·001*	27	6	*N.S.*
	No. 5	22	31	*0·001*	22	103	*0·001*	18	19	*0·025*
Neutral and pattern A′	No. 1	70	74	*0·001*	70	2	*N.S.*	59	4	*N.S.*
	No. 3	18	154	*0·001*	18	9	*N.S.*	14	10	*N.S.*
Pattern A and pattern A′	No. 1	57	101	*0·001*	57	37	*0·001*	55	9	*0·10*
	No. 3	19	171	*0·001*	19	21	*0·10*	15	4	*N.S.*

TABLE 6.—CORRELATION OF REACTION PATTERNS AND RENAL EXCRETION DURING MODERATE ACTIVITY AND RECUMBENCY

Condition	State	Output H_2O cm³/min	Output Na μeq/min	Output K μeq/min	Intake at previous meal H_2O cm³	Intake at previous meal Na meq	Intake at previous meal K meq
1-hour swim	Pattern A′	1·57	104	52	300	8	3
	Pattern A	0·82	60	50	900	97	53
	Pattern A	0·74	139	48	300	34	4
Walking 5 hours	Pattern A′	1·33	78	63	300	11	10
	Pattern A	0·63	108	50	990	76	47
	Pattern A	0·61	104	67	600	135	80
2-hour nap	Pattern A′, relaxed	1·19	91	48	650	51	27
	Pattern A′, relaxed	1·13	133	61	300	0	2
	Pattern A, but able to sleep	0·77	83	50	300	47	20
		0·63	103	49	200	31	4
		0·58	70	48	450	93	30
		0·33	37	47	150	47	7
	Pattern A, but not able to sleep	0·63	96	63	1200	43	28
		0·46	72	62	250	60	14
		0·30	58	69	500	77	29

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paper (SCHOTTSTAEDT *et al.*, 1956), observations were recorded showing variations in excretion rates of water and electrolytes in association with both unusual activity and recumbency in Subject No. 1. Some factor other than intake or activity appeared necessary to account for these variations. This material is presented in Table 6.

During one period of vigorous swimming, this subject felt relaxed and free of cares. On two other occasions, though swimming equally vigorously, she was alert to the dangers of her two small children playing near the water. She was ready to respond by

TABLE 7.—CORRELATION OF REACTION PATTERNS AND RENAL EXCRETION UNDER CONTROLLED LABORATORY CONDITIONS

State	Excretion rates		
	H_2O cm^3/min	Na μeq/min	K μeq/min
(a) Pattern A	0·56	18	10
Pattern A′	4·98	71	42
(b) Pattern A′	3·16	111	39
Pattern A	0·46	57	30
Neutral	0·60	105	56

swimming closer to them or to leave the water quickly if the situation called for such action. Urine volume during the period of activity accompanied by feelings of relaxation was 1·57 cm^3/min, while on the two occasions when the activity was accompanied by feelings of alertness and "tension" it was 0·82 and 0·74 cm^3/min.

During three observation periods, the subject walked for almost the entire five hours. On one test morning a period of four hours was spent "seeing friends off" for Europe and carrying her 22-lb son up and down the stairs and about the decks of the "Queen Mary." Despite the unaccustomed exercise, she enjoyed the morning. On two other occasions, similar periods of walking were accompanied by feelings of alertness and "tension." On one of these occasions she was assisting in wedding preparations and on the other she was conducting friends on a rapid tour of Manhattan. Urine volume was twice as great on the morning when exercise was accompanied by feelings of enjoyment and relaxation.

On several afternoons this subject rested for two hours while the children were taking their naps. On two occasions she felt fully relaxed and free from tension. On three occasions feelings of "tension" previously aroused in caring for her children were so intense as to prevent sleep during recumbency; she was restless, alert, and over-responsive to the noises made by the sleeping children. Urine volumes when recumbent and relaxed were 1·19 and 1·13 cm^3/min; while urine volumes when recumbent and "tense" were 0·30, 0·46, and 0·63 cm^3/min. Thus during recumbency as well as during activity, pattern A seemed to correlate well with decreased urine volume.

Short-term Observations.

The first subject was a 34-year-old nurse. She had been a subject in many experimental procedures previously and was familiar with the laboratory setting. However,

she knew the studies were connected in some way with behaviour and "emotions" and she did not wish to discuss personal topics with a strange doctor. She said later that she felt "alert" and "on guard" lest something "be put over" on her (pattern A). During the first hour she sat in the laboratory while an unfamiliar physician walked in and out about his duties. After collection of specimens, her own physician came into the room. She said, "When I saw him I felt a wave of relief pass over me," and both she and the observers were aware that she relaxed at this point (pattern A′). Both physicians remained in the room during the succeeding hour, which was spent in diverting conversation with the patient. Rates of excretion of water, sodium, and potassium for the period of "tense" and suspicious waiting and the subsequent period of relaxed and diverting conversation are given in Table 7(a). Despite the fact that the patient was fasting and had had no fluid for more than twelve hours prior to the experiment, there was a striking increase in urine volume during the period of sudden "freedom from tension." The increase in rates of sodium and potassium excretion bring these values into the normal range for neutral periods for this subject. Pattern A, therefore, had been accompanied by decreased water and electrolyte excretion and storage of fluid. Sudden freedom from tension was associated with release of this fluid.

The second subject was a 47-year-old secretary. Her chief complaint was multiple aches and pains associated with generalized muscle tension. Her lifetime pattern of behaviour was characterized by restraint and inhibition. She had worked more than twenty years for a man she detested, without trying to find a new job lest she get something worse. In addition, she was suspicious of all physicians and all test procedures. When she arrived at the laboratory in the morning, having fasted and drunk no fluid since the previous evening, she was told that due to unforeseen circumstances the test would have to be delayed an hour. She was then left in a familiar room to read a magazine. She appeared at ease during this period, and said she felt "relaxed." Following this, she was taken into an unfamiliar laboratory setting, given an intracutaneous injection, and told this was a skin test which would have to be observed carefully over the succeeding hour. During this period she sat rigidly in her chair, speaking only in response to direct questioning and always in monosyllables. Her posture and movements made it appear to the observer as though she were especially alert, though she subsequently stated only that she felt "a little more tense" during the second hour than the first. Excretion rates during the three hours of the experiment are given in Table 7(b). A decrease in fluid and electrolyte excretion was noted during the hour of "tense," restrained sitting. Excretion rates of all substances studied increased during the subsequent hour, which would indicate that retention was not due to depletion of body stores.

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SUMMARY AND CONCLUSIONS

The data presented in this paper may be summarized as follows:

(1) In 94 situations which these five subjects perceived as threatening, but which they felt they could meet adequately by alert behaviour and readiness for action, there was a significant decrease in rates of excretion of water and sodium as compared with 119 situations which these same subjects considered neutral and tranquil.

(2) In 30 situations which these subjects felt had elicited sudden feelings of release from tension, or sudden relaxation following sustained effort, there was a significant increase in rate of excretion of water but not of sodium as compared with 119 situations which these subjects considered neutral and tranquil.

(3) In Subject No. 1, these variations were noted whether the subject was engaged in moderately strenuous activity or was recumbent and inactive.

(4) Two instances are recorded where these reaction patterns were reproduced experimentally, with similar alterations in rates of renal excretion.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 160 to 166. Pergamon Press Ltd., London

THE PSYCHOLOGIST'S CONTRIBUTION TO CLINICAL METHOD*

A CASE OF ULCERATIVE COLITIS

JOHN GRAHAM WHITE†

1. INTRODUCTION

THE clinical psychologist is a relative newcomer to the health services. In this country, in fact, he is a product of the last war and the post-war period, his entry having been made via his work in the armed forces and in the rehabilitation centres set up towards the end of hostilities. At the end of ten years or so he is still trying to find his proper place in this new applied field; and a number of views have been expressed, notably by EYSENCK (1950) and SHAPIRO (1951), from the Institute of Psychiatry, London University, and by RAVEN (1952), from the Crichton Royal Hospital, Scotland, as to what he should best be doing there.

In defining their role there seems to have arisen in the minds of some clinical psychologists a dichotomy between routine clinical work, on the one hand, and, on the other, research investigations of groups of hospital patients and non-hospital controls; or, more recently, between the research activities of psychologists and the therapeutic activities of clinicians, whether psychiatrists or psychologists.

This tendency is not peculiar to British psychologists, but is evident among American psychologists also; and WITKIN (1954) has recently drawn attention to it: "There is a tendency to speak of them (experimental and clinical psychology) as though they represented two different fields. This is not really true. Whereas clinical psychology is a field, in the sense of being devoted to a certain content, experimental psychology, strictly speaking, represents a method, which may be applied to many fields, including the clinical."

The distinction, although admittedly an artificial one, and perhaps tacitly recognized as such, is in practice real enough. RAVEN (1952), for example, in describing his training programme for clinical psychologists, speaks of the research and the clinical psychologist as if this person were expected to behave differently at different times, according to whether he finds himself in a research or a clinical situation: thus, "Although routine work and research can seldom be satisfactorily combined, it is the day-to-day problems which the clinical psychologist encounters in his work that bring to his notice psychological problems of theoretical and research importance. While it is here that he encounters his problem and realizes its significance, it is only if he can be free to formulate and investigate his problem systematically, unhampered by routine commitments and immediate positive results, that he is likely to make any genuine contribution to its solution." In the quite different context of a recent paper, HETHERINGTON (1955) drew a specific distinction between the psychologist in the therapeutic role and the psychologist in the research rôle.

* Based on a paper read at a week-end meeting of the British Psychological Society, Northern Branch, at the University College of North Staffordshire, 23 July 1955.

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Now, the implication behind this would appear to be that one can only be experimental in his methods of work if he is doing research involving numbers; and the role of the psychologist as experimentalist in his work with the individual patient thus seems to be overlooked. Conversation and correspondence with the psychologists at the Crichton Royal Hospital, however, reveals that this is not so. Both RAVEN and HETHERINGTON would appear to agree that the difference, in practice, between "routine clinical work" and "systematic research" is that in the one the principles of experimental method tend to remain implicit, while in the other they are stated explicitly. It is the contention of the present paper, however, that they should be made explicit as much in clinical work with the single case as in research with large numbers, if the psychologist is to make the maximum use of his academic training and provide an optimal contribution in the clinic or mental hospital.

It is this that the psychologists at the Maudsley Hospital are attempting to do. They have stressed increasingly the need to carry over into clinical work the experimental methods of the psychological laboratory, at first in the study of diagnostic problems (SHAPIRO, 1951) and, more recently, in the treatment of patients (GWYNNE JONES, 1955).

This emphasis is healthy and to be encouraged; and it may in future demand a change in the expectations of both teachers and employers of clinical psychologists as well as of their medical colleagues. One should point out, however, that it is only the emphasis that is new, and that what is being emphasized is, at least in principle, not new, either in clinical psychology or in clinical medicine. And here one cannot but disagree fundamentally with BELLAK (1954) who writes in his recent book on the thematic apperception test, "In clinical practice there is no place for experimentation."

For whenever the psychologist is asked to give an opinion on any case, he sets up some hypothetical explanation, selects the appropriate methods of testing it, and observes whether his findings are consistent with it. For example, a boy is failing in his school work: the psychologist argues that if this is due to lack of capacity, the boy's scores on some test of scholastic aptitude will be of such-and-such an order, and proceeds to put this hypothesis to the test. If the child has in fact the capacity to succeed, the first hypothesis is rejected and some other explanation is postulated, such as that the boy's failure is a response to too-great parental insistence on success; and the prediction is made that, if this is so, it will determine the child's attitudes to his parents as these may be revealed in some appropriate attitudes test. Similarly, if the question is whether this 17-year-old girl's aggressively anti-social behaviour is the reflection of a constitutional psychopathic predisposition or a reaction to an intolerable life situation, for each hypothesis the psychologist will predict appropriately different responses to, let us say, the Rorschach and the thematic apperception test.

In this general logical approach to clinical problem-solving the psychologist has, of course, no monopoly. The psychiatrist works in the same way. He will postulate, for example, that if a patient is indeed schizophrenic, then, in the course of his interview, he will expect to observe the following: lack of emotional contact, inappropriately expressed effect, bizarre explanations of ordinary events, thought-blocking, and so on, through a long list of behaviour items. If a large number of such items is indeed observable, and these are consistent with information about the patient from other sources, he will accept the hypothesis of schizophrenia. If, however, in the

psychiatrist's opinion there are too few such items, and these are inconsistent with other information available to him, he will reject the original hypothesis and propose another, which he will proceed to test as before.

If this is the conventional clinical method, what, one may ask, is the difference between it and that sponsored by the Department of Psychology at the Maudsley Hospital? The difference is surely not one of kind, but of degree, and lies perhaps chiefly in the spelling out beforehand of the hypotheses to be tested, the procedures to be used in testing them, and the results to be expected from the application of such procedures. Thus, the clinical problem is formulated in terms of some testable hypothesis; that is, an independent variable is introduced in the form of some experimental technique, possibly a standardized test, and a dependent variable is identified; that is, the performance of the patient in the selected experimental situation is specified. In other words, an explicit prediction is made that certain results will be expected to confirm the hypothesis, while other results will be accepted as failing to do so. Further, controls are provided, which take the form of either normative data appropriate to the independent variable, or, if these are not available, some estimate of the relationship that the behaviour of the dependent variable bears to chance. Precautions will also be taken to prevent the investigator's own motivations from interfering with his analysis and interpretation of the results.

An illustrative case may help to make this clearer.

2. EXPERIMENTAL ORIENTATION TO THE SINGLE CASE

The case is one of a boy of ten, suffering from ulcerative colitis. The clinical work to be described is not at all ambitious; it represents what is probably the minimal level of analysis consistent with the demands of the case-lead. The psychiatrist's history and clinical impressions will be presented first, to be followed then by some theoretical assumptions made by both psychiatrist and psychologist and, finally, a definition of the scope of the specifically psychological investigation.

(a) *Psychiatrist's Impression of Mother and Maternal Grandmother*

The principal informant was the boy's mother, a Roman Catholic and a highly respectable, over-anxious woman. A chronic worrier and stickler for cleanliness and tidiness, she still washes her ten-year-old son and powders him at night. She is reluctant to leave him with his grandmother in the evening, although the latter has had considerable responsibility for his up-bringing. She seems to have a fixed idea about bowel regularity and "cleansing the system." The maternal grandmother, who was also interviewed, is described as being dominant, a hard, strict, non-sentimental type of woman.

(b) *History*

The boy is an only child, born out of wedlock. Since his mother had to go out to work, he attended a day nursery from the age of twelve months to about four years, an experience which he is said to have accepted equably. From four to five years he was cared for during the day by his grandmother. Two years ago his mother was married to a man whom the boy had previously known as "uncle" and now accepted as "father" without demur. Changes of house and school, occurring about the same time, were also accepted by the boy without any overt reaction.

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The child was toilet-trained from infancy, being "potted" as early as one month. His bowels are described as having been "stubborn" from an early age, which led his mother and grandmother and, more recently his father, to inquire constantly whether he had had a movement. Failure of the bowel to move over a 24-hour period resulted in the administration of syrup of figs or milk of magnesia, his mother being concerned about the possibly "poisonous" effects of the retention of stools.

This mother describes her son as considerate and unselfish, a good boy who never cries or loses his temper, accepting rebuffs and disappointments without ever getting overtly upset. He is very tidy in his personal dress and resents dirty linen. He has a high respect for authority, in the form of school, police, and doctors, and is scrupulously observant of his religious duties.

On an earlier admission to hospital with the same complaint this boy was given a course of ACTH, during which his behaviour seems to have undergone a dramatic change, the boy becoming demanding, inconsiderate, and even openly aggressive towards his mother. At the same time he expressed a strong desire to read "horror comics," which especially filled his mother with alarm. With the withdrawal of ACTH the boy is said to have reverted to his normal "good" self; but when a second course was begun he became "different" again.

(c) *Formulation of Clinical Problem*

At the outset, while we may keep at the back of our minds the hypothesized relation between soma and psyche in cases such as this, we can do nothing about that hypothesis until we have identified the relevant variables to which the clinician is going to attend in the psychotherapeutic situation that may arise if and when medical treatment breaks down, as it has done in the past.

On the basis of the history and the clinical description, therefore, we may hypothesize certain relationships between this boy, on the one hand, and his encompassing life situation on the other, and then choose the best methods available to us for demonstrating whether these relationships exist. All we want to do, to begin with, is to define the relevant variables with somewhat greater precision and objectivity than has been possible in the clinical interview.

We propose, therefore, that this is a very docile boy but that his docility is achieved at the expense of severely inhibiting aggressive impulses, which impulses might be expected to be directed primarily against his mother.

Direct questioning of the boy, we may be sure, will not produce valid answers to the sort of questions we should ask. What other methods, then, are available to us which will help us to identify the significant variables?

We badly need at the present time objective psychological tests of such clinically significant variables as attitudes to parents and siblings, hostility, passivity, immaturity. . . . A few such tests have been developed in the United States; but they are of dubious relevance to English populations. In the absence of tests standardized in this country, we are obliged to have recourse to such relatively inexact methods as the so-called "projective techniques."

Of these there are two that may provide us indirectly with the information that we seek in this case; namely, the Rorschach and Murray's thematic apperception test (hereafter referred to as T.A.T.) or some similar picture-story technique. If we

decide to use these methods, we shall have to reformulate our original clinical hypothesis in terms of the logic upon which each is based.

(d) *Testable Hypotheses*

In other words we must set up reasonable hypotheses in terms of perception and motivation theory, as exemplified in these two techniques. In the case of the Rorschach, therefore, we may postulate a higher than normal $F\%$, a lower than normal number of responses making use of the colour stimulus, and a higher than normal number of rare-detail responses. Secondly, with regard to the T.A.T. we should postulate that the boy would reveal in his stories a certain conception of, or attitude towards, older women that would differ from the conception of or attitude revealed towards men. We might further postulate that aggression, if it appeared at all in the T.A.T. stories, would be quickly suppressed.

(e) *Testing of Hypotheses*

Rorschach. The relevant results from the Rorschach were a total number of responses of forty-eight, of which four were whole responses, twenty-one were large or small usual-detail responses, and twenty-three were rare-detail responses. There was no response involving either human beings seen in movement or colour; not one concept was enlivened by making use of the suggestions of movement, texture, or colour contained in the ink blots; the boy adhered painstakingly to the formal "givens" of the situation, paying attention to the minutest details, and was not prepared, apparently, to take any liberties with what he saw; in other words, he gave us a non-committal, severely constricted record, the $F\%$ being one hundred.

Since many of the inferences made from the Rorschach "signs" have the status of untested hypotheses rather than facts, the interpretation of these results is a hazardous undertaking. If, however, we accord some validity to the $F\%$, for example, as being indicative of perceptual control, and not merely of low intelligence (this boy scored at the 90th percentile on *Raven's Progressive Matrices*, 1947), then the perceptual control of this boy is certainly excessive; and if we are right in our assumption that the response to the perceptual task of the Rorschach is related to the organization or structure of the personality, we see in the present case a personality organization that restricts all outward expression of emotion.

Thematic apperception test and Symonds picture-story test. In the present case we are dealing with a very rare physical condition. We have no behavioural or personality norms for boys of 10 with ulcerative colitis (nor, for that matter, for only boys of 10 living with their mothers and maternal grandmothers for most of their lives); nor would it be appropriate to use such normative data as exist for adults with ulcerative colitis.

Lacking such norms, we have to assess the import of the stories against such internal criteria as the frequency with which certain themes, outcomes, events, expressed attitudes, etc., appear in them, assuming, in so doing, that frequency of occurrence has psychological significance. Having counted the number of times a particular event or attitude occurs in the stories, it is necessary to compare the frequency with which it occurs with the likelihood of such an event or attitude's occurring so frequently by chance. This in turn necessitates the adoption of some realistic equal-probability hypothesis such (as in the present instance) as that of

ambivalence, where we have assumed that it would be probable for the normal ten-year-old boy to entertain feelings of both affection and hostility towards his mother.

Relying upon these assumptions, we take as large a sample of the person's fantasy productions as time allows. We have found that twenty to twenty-five are the minimum number of stories needed for analysis, fewer than this providing us with usable "hunches," but no more. In the present case twenty-four pictures were used. Inspection of the resultant stories (by three independent judges) revealed that in sixteen of the twenty stories containing references to women; these women were the object of a variety of negative experiences (sentiments or events) ranging from resentment and defiance to death by shooting or strangulation. As an example of a mild expression of negative sentiment we may cite the story in which a boy resents the application by his mother of a lie-detecting belt, which gets tighter when the boy is telling lies. An example of a violently negative event would be the following: "This lady married a man and the man wasn't very nice to her and he often tried to kill her, and this night she was asleep in the bed and her husband came upstairs and tried to strangle her and she managed to let out a scream and the neighbours heard her and rang up the police and the police came and found her body lying on the bed and she was dead. And they started to look for clues of the man who killed her and they found some footprints and started tracing him and found him hidden in the cellar and he had a gun in his hand and he shot one of the policemen and before he could shoot another policeman they were all on him and captured him and took him to prison and then hung him." The sentiments and events affecting men in the twenty-one stories in which men appeared were, by contrast, favourable to them in sixteen stories and either negative or neutral in five. These differences are significant at the 0·05 level of confidence or better (using chi-squared, with Yates's correction for small numbers).

As a result of his analysis of fantasy productions of this kind, the psychologist wants to be able to say rather more than simply "for a boy who has the reputation of being so docile and well behaved there is a remarkable amount of criminal activity in these stories." He wants to know something about the relation, either to comparable normative data, or, at the very least, to chance, of all this criminal activity in the fantasy work of such an inhibited person as the story-teller. If he knows this he can at least pass on to the therapist something "harder" than mere speculation. In the present writer's opinion, no projective-type investigation should escape such handling as that described here (namely, the setting up of reasonable hypotheses and taking sufficient samples of behaviour to make statistical analysis meaningful), unless of course there is great urgency regarding the immediate disposal or treatment of the patient, when, perhaps, we must be content with much lower levels of confidence.

Even so, what the psychologist can pass on may still not be very much. For example, in the case under consideration, we cannot say that the mother is a "bad object" for this boy. All we can say is that bad things happen to older women in this boy's stories more often than they happen to men (if we exclude the punishments meted out to men for attacking women). The women died or are dead when the story started, or they are hated or robbed or shot more often than we should expect this to happen to them by chance in such stories. On the other hand, in the present case we can add that the person responsible for any act of aggression is punished on every single occasion. ($P = 0{\cdot}01$.)

Nor, of course, can anything be said about the presumed positive relation between ulcerative colitis and personality structure or content. At the end of our labours we have only a set of fairly well-defined data with which to compare data on the same variables after deliberate intervention, either medical or psychotherapeutic, has taken place. If the psychiatrists are right in their assumption of a causal relationship, the effects of medical treatment will not be permanent, and the attempt will be made to change the mother's attitudes to the boy. We can then observe the effects of manipulation of this independent variable on some dependent variable, e.g., older women in the T.A.T. story, as well as on the somatic condition. We have, moreover, collected a number of relevant and fairly objective observations about this boy that may be compared with similar observations in other cases showing identical somatic symptoms. It is, perhaps, the beginning of an approach to an explanation of the relationship between personality variables and ulcerative colitis in children.

3. CONCLUSION

In the foregoing, an attempt has been made to show that there is no fundamental antithesis between the experimental and the clinical approach. Although not always an easy task, experimental method can and should be applied to clinical data whenever possible. The fact that it is not so applied or not often enough is no doubt partly due to lack of time. The above work on a single case represents five interviews with the patient and approximately fifteen hours of work for the psychologist alone. That so much time can be spent on one patient is due solely to the fact that the psychologist, unlike the psychiatrist, is not encumbered with responsibility for the care and treatment of many patients.

The systematic study of personality takes time, whether it be of the single case or a group of cases; but this is surely the proper concern of the clinical psychologist, if he is to retain any link with his undergraduate studies or, in fact, to remain a psychologist at all.

Acknowledgements—I am greatly indebted to Dr. R. McL. TODD, Senior Lecturer in the Department of Child Health, University of Liverpool, and to Dr. P. PINKERTON, Consultant Psychiatrist, Alder Hey Hospital, Liverpool, for permission to use their case of ulcerative colitis in a boy of 10 for illustrative purposes in this paper.

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CONFERENCES

THE first meeting of European research workers in the field of psychosomatic medicine was held at the Maudsley Hospital, London, on 22–23 April 1955. The conveners of this conference, Dr. J. GROEN and Dr. DENIS LEIGH, had received an enthusiastic response to their original enquiries as to the need for such a meeting, and workers from twelve countries had expressed their intention of taking part. A programme was therefore drawn up, designed to ensure the maximum of participation in discussion, the chief theme being "Methodology in Psychosomatic Medicine". Four topics were chosen: bronchial asthma, peptic ulcer, skin diseases, and the problem of specificity in psychosomatic disorders. Representative workers were asked to present papers relating to the methodological approach in these particular disorders, and the meeting was limited in size, so that worth-while group discussion was possible.

Fifty-five workers from eleven countries attended. The speakers initiating the discussions were as follows:

Bronchial Asthma

Dr. Denis Leigh (chairman), Dr. J. Groen, Dr. E. Dekker, Dr. R. S. Bruce Pearson, Dr. E. B. Strauss, Professor J. J. Lopez Ibor.

Peptic Ulcer

Dr. J. Groen (chairman), Dr. Gerdt Wretmark, Dr. Max Hamilton, Professor A. Jores, Dr. Poul Kirketerp.

Skin Diseases

Dr. J. Groen (chairman), Dr. Ida MacAlpine, Dr. H. Musaph, Dr. J. Guild, Dr. Solange Lambergeon.

The Problem of Specificity

Dr. Denis Leigh (chairman), Dr. R. Pierloot, Dr. J. W. Paulley, Professor Barahona Fernandes, Dr. Rof Carballo.

A business meeting was also held, where it was decided that the time was not yet ripe for the formation of a European Psychosomatic Association. However, a unanimous decision was taken to hold a second conference in 1956 in Amsterdam, and arrangements for this were left in the hands of Dr. J. Groen. A later announcement will be made concerning the date of this meeting.

Abstracts of some of the papers given at this conference are printed below.

Dr. E. B. STRAUSS, *London*

Like the other speakers, I wish to state my position in relation to the concept of "psychosomatic medicine" before I consider asthma specifically. The whole of medicine is, of course, psychosomatic, seeing that man is an indissoluble psychosomatic unity. When we choose to regard the psychic element in a human situation or stress the somatic factor, we are merely abstracting from a totality, or, if you wish, viewing one or other of two different aspects of one and the same thing.

If, on employing the term psychosomatic medicine, we are primarily thinking in terms of etiology, we are in danger of offending the principle of multi-dimensional etiology; for every morbid reaction-formation (every healthy reaction-formation, for that matter) must be assessed from four etiological standpoints: (1) psychic, (2) somatic, (3) constitutional and genetic, (4) social.

It will be seen then that, both from the philosophical and the semantic point of view, the term psychosomatic medicine is not a term that greatly appeals to me. Nevertheless, it is becoming clear that certain nosological entities (if that term has any ultimate meaning) are more profitably to be studied from the psychic than from the somatic angle than they were previously thought to be; and bronchial asthma belongs to that rapidly expanding group.

I should also like to draw a distinction between the terms psychic and psychogenic. Psychic (including psychoid) processes do not necessarily involve a logical chain of cause and effect viewed from the teleological angle. Psychogenesis, on the other hand, presupposes such a purposive element (usually unconscious) and assumes that the processes can be consciously appreciated and modified by the use of psychoanalytical techniques.

I believe that psychogenic asthma is a rare condition whereas the psychic factor in bronchial asthma is ascertainable in some 90 per cent of total cases. I described two cases of psychogenic asthma in the *Lancet* as long ago as 1927, and since then I have come across several more such cases. In other cases asthma has suddenly complicated a pre-existent anxiety-state in which claustrophobia was a marked feature. Such patients declare that an attack of asthma constitutes a translation into physical terms of their feelings of mental suffocation and constriction.

Having to my own satisfaction, established the existence of psychogenic asthma (psychogenic in the narrower sense), I attempted between 1933 and 1936 to evaluate the degree in which the psyche participates in "the asthmas" in general.

To achieve my object, I attempted to answer some or all of the following questions about each patient.

(1) Does the patient volunteer the information that he is, generally speaking, "nervy" apart from his asthma?

(2) Does he state that excitement or emotion of any kind precipitates an attack?

(3) Does he habitually live under conditions involving excessive worry or emotional strain and stress?

(4) Is he temperamentally a person who finds it difficult to adapt his social environment?

(5) Is his libidinal life reasonably and legitimately satisfied or satisfiable—judging by superficial standards only?

(6) Are there any obvious pointers to determinant complexes in the psychoanalytical sense?

(7) Is a purposive (unconscious) factor easily detectable and probably a link in the causal chain?

(8) Does the patient superficially impress the investigator as being "neurotic" or as well-balanced?

(9) Is the family history "neuropathic"?

The main objection to such an investigation is that the subjective element enters into the evaluation of the results to an undesirable extent. But, granted an ordinary degree of integrity on the part of the investigator, the subjective error need not seriously vitiate his observations.

Material—The patients, thirty in all, were placed at my disposal by the Asthma Clinic at Guy's Hospital. There was no kind of selection exercised, except that children were excluded from this particular investigation, as I had published a communication on the asthma problem in childhood two years previously.

Procedure—The patients were instructed to present themselves at a certain hour without being told the nature of the investigation; in fact, the majority thought that the interview with me was an ordinary routine affair. The patients were interviewed for about three-quarters of an hour on the first occasion. As often as not they were not interviewed a second time, but some patients presented themselves at varying intervals to report progress. As a general rule, it was possible to obtain an impression of the patient together with his history without asking many leading questions. Suggestive questions were never put to the patient. Patients were not given the impression that their interviews were therapeutic in intent, and yet in many cases two or more interviews were followed by a distinct improvement in the patient's condition. (i.e., diminution in frequency or disappearance of asthma attacks). Whether such changes are due to suggestion, or are the result of the mild degree of psychocatharsis occurring in interviews, cannot be determined; but on either hypothesis such an improvement would be an additional piece of evidence in favour of the acceptance of the view that the psychic element in asthma calls for consideration.

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I called this special technique the ten-point-scale method. It had many points in common with CULPIN's six-point scale, but I had worked out the method long before I was aware of his scheme. Of the thirty cases, the psychic element was found to be strongly present in sixteen, well represented in nine, and feebly but definitely represented in four. The psychic constituent of the syndrome was only undetected in one case

What are the conclusions which can be legitimately drawn from these results? It would, perhaps, be wise if one were to point out a false inference, viz., that asthma should be classified as a psychoneurosis. The furthest that one can go is to conclude that, even in the presence of the allergic diathesis, psychic factors contribute to the asthma syndrome in greater measure than has previously been thought likely. The study of detailed case histories show that this particular participation takes various forms.

(1) In its psychic aspects, asthma may in certain cases be complex-determined, i.e., included in the group of the conversion hysterias.

(2) A person with the allergic diathesis, who is temperamentally a deviant from the conventional norm of his immediate social group, is likely to develop the asthma syndrome.

(3) An asthmatic subject is liable to make his asthma the centre of his life, i.e., to develop and cultivate an asthmatic *persona* (to use one of JUNG's terms). Such a person by the mechanism of what KRETSCHMER calls arbitrary reflex reinforcement can "turn on" his asthma whenever it suits his unconscious or preconscious purposes.

(4) Allergic subjects who live under conditions of extreme emotional strain and stress are liable to exhibit the asthma syndrome.

(5) Asthma is an allergic subject may be part and parcel of a general anxiety state, the effect, when the anxiety tension is very high, finding an autonomic-reflex outlet.

If these conclusions are justifiable, they suggest that psychotherapy, in the widest sense of the term, should reinforce physical methods of treatment (desensitisation, breathing exercises, and the like), the form of psychotherapy being determined by the case history. Analytical psychotherapy would appear to be indicated in groups 1 and 5. Patients who fall into groups 1 and 2 should benefit by a personality analysis, as opposed to an experimental analysis (*vide* KRETSCHMER), and should be taught how to accept and adapt themselves to their own temperamental patterns. In the case of group 4, it will sometimes prove possible by means of active interference to modify the patient's environmental conditions. Patients who fall into group 3 should respond well to suggestive methods with or without hypnosis.

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Dr. R. S. BRUCE PEARSON, *London*

Considerable factual knowledge concerning asthma has been accumulated from work in different fields, and it is appropriate that some of us should meet in an attempt to integrate our findings.

Research can be undertaken at three levels: the statistical, the clinical, and the fundamental. The first provides us with information concerning the size and social significance of the condition, and is still a fruitful field for further work. Clinical investigation produces the most striking advances in the early stages. This can be appreciated by a study of the careful observations of HYDE SALTER and the experimental work of BLACKLEY in the last century. Fundamental studies may then help to elucidate the pathogenesis and to suggest therapeutic remedies, as did the discovery of anaphylaxis, of histamine, and later of the antihistamine drugs. The clinician continues to do useful work by correlating the findings from the different lines of approach and applying the discoveries of fundamental workers at the practical, clinical level. There is thus a constant interchange of experience between workers in these two fields.

At the clinical level there is a special need for integration between those working in psychiatry and those concerned with the problems of allergy and infection. It must be shown, for example, what mechanisms in emotional disturbances bring about attacks of asthma. Are these mediated by changes in sympathetic and parasympathetic nervous tone, or by endocrine disturbances, or do they operate by exploiting allergic mechanisms already in existence? Psychiatric work on asthma has in the past been too much of a descriptive nature (which may be influenced by the viewpoint of the psychiatrist), and too little attention has been paid to measurable criteria. What effect, for example, does psychotherapy have upon the demonstrable allergic mechanisms and upon the incidence and severity of respiratory tract infections?

There is also a special need for long-term studies of asthmatics by a combined team consisting of allergist, psychiatrist, and pathologist, rather than those studies of brief duration at present so often undertaken by solitary biased observers confused by the natural variability of the disease.

Dr. IDA MACALPINE, *London*

Psychosomatic medicine should not be divided into diseases of particular organs or organ systems, because it deals with the whole patient. Psychosomatic symptoms—best defined as somatic symptoms which can be understood through the mind and influenced by psychotherapy—express unconscious emotions or unconscious fantasies. Psychological awareness of an emotion may be lost while its physiological accompaniments, thus isolated, persist and so become pathological.

Diagnosis may be difficult, particularly for physicians when patients' delusions and hallucinations remain confined to their bodies and body functions without affecting their relation to external reality.

Spreading dissatisfaction with the approach to assessing personality types is due to its giving rise to an epithetic classification by the misuse of psychoanalytic terms reflecting on some aspects of the patient's character or personality, without furthering clinical understanding or psychotherapy.

In the absence of a meaningful psychiatric classification, there is little value in presenting statistics.

The investigation of peripheral mechanisms belongs to the field of pathophysiology. In its etiological (i.e., psychodynamic) relations, psychosomatic medicine, if it is to survive, must become a branch of clinical psychiatry.

Dr. H. MUSAPH, *Amsterdam, The Netherlands*

For three years I have been working as a psychiatric research worker in psychosomatic medicine at the Department of Skin and Venereal Diseases of the University of Amsterdam.

Procedure—Adult patients with the diagnosis of urticaria, atopic dermatitis, or pruritus, and those who appear to have serious psychic difficulties, are passed on for examination; this includes a psychiatric examination (eight to ten interviews), a psychological investigation (Rorschach, F.P.T., T.A.T.), and, recently, a milieu examination by a social worker. The data of the dermatologic, psychologic, and social reports may be of great importance for the evaluation of the psychiatric data. In our search for the genesis of the skin disease we always find a series of moments with a pluricausal determination of each symptom; the skin symptoms (for instance, itching), being completely blended with the existing neurosis. Without involving unconscious forces, a neurotic symptom cannot be understood. Psychoanalytic therapy being impossible for several reasons in most cases, the question arises as to what extent it will appear possible to approach the genesis of psychosomatic symptoms with the above-mentioned team, and a restriction to about ten psychiatric interviews. This question can only be elucidated by means of practical experience and much comparable material. Exploring individual cases in a standardized way will facilitate comparison; the use of the directive method, involving a questionnaire technique, of which an English translation has been presented, is being recommended.

Dr. SOLANGE LAMBERGEON, *Paris*

Two points of methodology are studied: physiological and psycho-physiological study of certain dermatoses, and objective psychic examination of these cases.

Psycho-physiological studies of skin disorders are as yet very few in number. They include the work of MITTELMANN and WOLFF on the effect of emotional stress on cutaneous temperature in normal patients and in Raynaud's syndrome; the study of cutaneous capillary reactions by using a photo electric plethysmograph (DEUTSCH); investigation of the capillary response to emotion (KRAMAR), of the cutaneous reaction to histamine introduced by iontophoresis (OBERMAYER), and of cutaneous electrical resistance in the course of a provoked emotional stress (VAN DER VALK and GROEN).

This experimentation is necessary, and should be watched with a growing interest in order to state with accuracy the psycho-physiological mechanisms of the skin. However, even if all these works may throw a new light upon the physiological processes which are part of the psychosomatic reactions, they are utterly deprived of an element which is important in the classical study of the psychosomatic dermatoses, that is, the psychological and indeed the psychopathological structures

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of the patients. Dermatological practice shows that there exist different psychic structures rather than specific patterns, and that neurotic or pre-psychotic mechanisms, or even psychotic mechanisms, are each connected with a different dermatological group.

Is it possible to proceed with an objective study of the psychologic dynamisms of the patients on one hand, and of their psychic structure on the other hand? This is the aim of psychological tests and especially of such projective tests as the Rorschach or the thematic apperception tests, which have been studied in France chiefly by DE GRACIANSKY and STERN.

Mention should be made of electro-encephalography, which verges on the two groups of studies. Hitherto it has been very little studied in psychosomatic affections, particularly in dermatology. Yet the EEG often shows anomalies which, although very often non-specific in nature, nevertheless should certainly be studied very carefully in the future.

It is only by a comparison of both clinical, laboratory, and other data, in both normal and patient populations, that a truly scientific basis for psychosomatic theory can be developed.

Dr. JULIUS GUILD, *London*

This study involves evaluation of four therapies in patients with eczema of internal origin: group and individual psychotherapy, hypnosis, abreaction. At least six months were necessary to explore the theoretical, methodological, and personal difficulties encountered. In each, the importance was noted of the human element in both investigator and patients.

Theoretical problems include confusion of orientation in the investigator (i.e., between theory and therapy); or whether psychological factors can be linked with a lesion simply because that is the presenting complaint. It emerged that the direct correlation of personality with a specific pathology seems too narrow a concept—it neglects the total of intraorganismal reactions of which the lesion is only a visible part.

Methodological problems involve the impossibility of dividing patients into matched groups for therapy. Some forms cannot be used in all cases. Random sampling is therefore not possible, and treatment is dictated by clinical judgement. Such judgement requires assessment of criteria for each therapy, and of personal prejudice. The literature gives no reliable account of criteria for various therapies, or of spontaneous remission, or prognosis of eczema with usual dermatologic therapy.

Personal factors in the therapist which influence therapy include his training and orientation, his prejudice for a particular treatment, his ability to use therapies he doubts, selection of patients he favours for his favourite therapy; his personality—whether active or passive, dominant or demanding; his enthusiasm, and the degree of suggestability he introduces into all therapies.

This project, designed according to established procedure, was found to be static. It failed to foresee the significance of the human element in research into therapy. Such research is best done by a team of investigators. There is a great need for a methodology which takes into account dynamic co-variables of (a) patients, not as fixed examples of pathology, but as people, in whom an illness occurs, (b) therapists, not as constants, but as variables subject to the vicissitudes of their own needs, and training prejudice, as they react to their patients. The validity of results in any research into therapy may depend upon whether these factors have been considered.

Professor A. JORES, *Hamburg, Germany*

The etiology of the peptic-ulcer disease is a question which cannot be answered by using the methods of the natural sciences. So there arises the suspicion that the etiology of the ulcer is more a psychological problem. We see, indeed, that a satisfactory explanation of ulcers is possible when the psychological approach is taken. Then we learn that an ulcer patient is an individual with inhibitions especially with respect to the achievement of possession, and at times also to the maintenance of possession, and with the inability of attaining his end. Unsolved emotional experiences, when suppressed, remain coupled to the same somatic reactions as normally, with the difference, however, that it retains its influence (ALEXANDER and WOLF; WOLFF *et al.*). So the somatic reaction coupled with the suppressed emotions remains permanent, and takes on the character of a true illness. So an ulcer may develop in the stomach, which behaves as though it were getting food although it is receiving none. But only those individuals are disturbed in their striving for possession who have acquired "orally" inhibitions in the early childhood. A satisfactory explanation of ulcers is possible when the psychological approach is taken. A differentiation of duodenal ulcers and gastritis is not yet possible on the basis of psychological studies, however. Medicine until now has held the

opinion that the "anlage" so important for the etiology of ulcer is based on a hereditary factor. An increase in the incidence of ulcers in certain families may be the result of environment with the same degree of likelihood as the result of heredity. So it may be that the so-called anlage is the environmental factor of early childhood.

Dr. MAX HAMILTON, *Leeds, England*

This paper is concerned with duodenal ulcer as a special example to illustrate general problems in psychosomatic theory. Theories have been concerned chiefly with predisposition (psychological) and with the mechanism of production of lesions (physiological). The former delineated specific types of personality or unconscious dynamics, and the latter were variations on the Cannon-Bard theory.

The theory of types of personality consisting of clusters of traits is too static, since personality does change naturally and in the course of successful therapy. Furthermore, the generality of trait names may be misleading. The personality in duodenal ulcer, once very elaborate, has now little more than anxiety left to it. Unconscious dynamics have considered hysterical conversion (now abandoned), vegetative neurosis (meaningless), and regression (which explains everything). American work emphasizes conflicts pertaining to (oral) aggression and dependence. These appear to be problems of the cultural pattern rather than duodenal ulcer.

The former crude physiological theories have been much revised by the differentiation of patterns of response and of individual differences. Insufficient attention has been paid to endocrinological mechanisms. Not enough work has been done on changes specific to the quality of stress, as well as individual differences. Subjective differences must have an objective basis. Further work is required on correlation between physiological and psychological changes, using well-designed experiments and adequate statistical control (specific references given for each point).

Dr. GERDT WRETMARK, *Lund, Sweden*

The work was based on two series of peptic-ulcer individuals (P.U.s) in a healthy state investigated as to the gastric distress. The main series consisted of 170 P.U.s treated in a medical department and investigated at least seven years after their first admission. The second series was chosen from a psychiatric department where 120 P.U.s had been treated for some type of neurosis. Each series was compared with the same number of controls, selected so as to secure the highest possible degree of comparability.

The study was focused on heredity, body-build, and personality, and later the findings were correlated with the course of the disease. As to heredity, the results were in close agreement with those of DOLL and BUCH. The ratio of number of ulcers observed and number expected in brothers of P.U.s was 1·9:1.

A correlation and regression analysis of the body measurements showed that the breadth of the chest was relatively smaller in P.U.s than in others. And the narrower the chest, the worse was the course.

Personality was determined according to the Sjöbring system of variants.

In this system four variables or dimensions are assumed: capacity, stability, validity, solidity. The variables are conceived as "natural," implying *inter alia* that they are common to everybody in some degree, contrary to pathological qualities, which occur in a minority only. Every human being is thus supposed to have a certain position within each of these dimensions. The position in one dimension is independent of the position in the others. The variables are presumed to be normally distributed.

A brief description of each variable is given below.

1. Subcapacity—supercapacity: variation of intelligence.
2. Substability—superstability: variation from warm, realistic, heavy to coldish, abstract, elegant (syntonia—non-syntonia).
3. Subvalidity—supervalidity: variation from timid, cautious, tense, to alert, self-reliant, free.
4. Subsolidity—supersolidity: variation from impulsive, easily carried off, subjective, to steady, circumspect, objective.

Judging by the observations made, duodenal-ulcer individuals are more often supercapable (intelligence above average), superstable (non-syntonic), subvalid, and subsolid than others. Gastric-ulcer individuals do not seem to differ from others in any remarkable way.

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A tentative interpretation was put forward that a combination of supercapacity and subvalidity implies a discrepancy between a striving to maintain activity on a high level and a restricted power to do so, i.e., a source of chronic conflict. If this conflict is accentuated, it may be accompanied by autonomic disturbances, manifested also in the upper digestive tract, favouring the formation of chronic peptic ulcer. Superstability suggests difficulty in communicating with others, a certain degree of emotional isolation. It was further shown that the age at onset was probably correlated with the degree of stability, the disease appearing earlier in superstables.

It was also found that the frequency of P.U. in close relatives of superstable P.U.s was probably greater than in relatives of substable P.U.s.

It was demonstrated with statistical significance that the frequency of P.U. is higher among close relatives of healthy, superstable individuals, than among such relatives of other healthy individuals.

The picture of superstability is therefore not secondary to the ulcer disease.

The observations justify the conclusion that there exists an inherited predisposition for P.U. and that what can be described as superstability (non-syntonia) is an essential factor in this predisposition. Superstables (non-syntonics) are more inclined to have P.U. than others; they probably develop the disease earlier in life, and the prognosis is less favourable.

The assessment of body-build and personality as to degree of stability made it possible to divide most of the duodenal-ulcer individuals into two widely different prognostic groups.

Dr. Poul Kirketerp, *Horsens, Denmark*

Because there are so many ulcer patients and so few psychiatrists, and because most ulcer patients are disinclined to submit to lengthy psychiatric procedures, it is impossible to obtain psychiatric—let alone psycho-analytic—examination of more than exceptional ulcer patients. The interested physician is the man who has most opportunities for investigating and treating the psychosomatic factors in peptic ulcer. He may have little or no psychiatric education, but the ulcer patient's problems and personalities are so different from the common neurotic and psychotic patient's that even the psychiatrist needs special training before he tackles the ulcer patient's problems. Such training can just as well be obtained by the physician who from the start has the advantage of being joined to the patient in a patient-doctor relationship, and who in fact is the only person who can treat the patient's mind and body as a whole. A Danish hospital serving a population of 45,000 deals with about 100 in-patients with peptic ulcer every year. These cases are investigated by simple therapeutic interviews, special attention being focused on their life-history and their life-situation at the time of their first attack, and of any flare-up of their disease. In three-quarters of the cases there is an explanation, physical or mental, for the recurrence; and in the more dramatic manifestations such as melena, haematemesis, or perforation, only one in ten is unexplained. Although such investigations cannot claim to solve the deeper problems of the cause of peptic ulcer, they are useful for advising the patients and as a framework for more penetrating research. And they may be most useful in breaking down the artificial partition wall between disease of the body and disease of the mind.

Dr. R. Pierloot, *Louvain, Belgium*

Psychosomatic specificity should clearly not be generalized, and should be limited to certain phases of the psychogenesis of bodily diseases. Such a phase is, for example, that pathogenic emotional tension which is accompanied by a specific somatic disturbance.

Unresolved emotional tension is a particular form of the expression of an "inability" situation—to be distinguished from a psychoneurotic or conversion symptom. It is a passive experience of a defective relationship between the person and the world (being left alone, for instance, or being in a scrape, etc.). At the outset one could pose the question as to what specific psychological factors lead to such an experience, and what are the determining factors of the choice of a given form of emotional attitude. The specific somatic element of unresolved emotional tension is not a disease, but a physiological disturbance in an organic system. This disturbance may lead sometimes to organic damage, in other cases not. The possibility therefore arises of a comparative study of emotional attitudes in different clinical syndromes, based on analogical physiological disturbances.

Diseases clinically diagnosed as functional, that switch over to being organic, are so rare that we come to speak of different diseases, and not of different stadia of the same disease's process. In our comparative study of 120 cases, we gained the impression that the emotional attitudes in patients

with different diseases, based on analogical physiological disturbances, are similar (being left alone—gastric hyperfunction; being threatened—colon hyperfunction). This experience is based exclusively on clinical interviews, and may only be conceived as a provisional explanation further to be tested. The genesis of a given disease, coming forth from such a physiological disturbance, is probably determined by psychological as well as by somatic factors.

Dr. J. W. PAULLEY, *Ipswich, England*

It is suggested that the methods an emotionally immature person uses, or fails to use, to canalize his feelings to the outside world, may determine the disease he will contract. It is upon these relatively superficial characteristics or attitudes that the lay concept of personality is based, but which have hitherto been largely ignored by orthodox psychological thinking.

The tradition and culture of a community, nation, or civilization may influence the modes of expression an individual may adopt. These factors may account for the racial incidence of certain diseases. The mishandling of aggressive feelings may be paramount, in this respect, in the present age.

The ulcerative-colitis personality is almost a caricature. In what other condition, except colitis, perhaps Cröhn's disease, and mental deficiency, would mothers so often accompany their grown-up sons to the out-patient clinic or consulting-room? This excessively dependent and dominated role is at once noticeable in the male sufferer, though in the female it may pass superficial scrutiny.

Insomnia, depression, and self-pity, often the result of some deprivation, precede rheumatoid arthritis by weeks or months. The depression is often marked by smiling martyrdom.

In disseminated sclerosis patients, evidence of siblings, parents, and friends suggests that emotional detachment, later often identified as euphoria, has been present from early childhood. It may develop as a defence against love-deprivation in early life, and enable them to laugh in the face of catastrophe later, but not without cost.

Specificity exists, but it is not absolute. Psychosomatic personalities fall into groups as close as the colours of the spectrum, and similarly merge at the edges. Proof of specificity will depend on improved methods of measurement.

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BOOK REVIEW

Modern Trends in Psychosomatic Medicine. Edited by DESMOND O'NEILL. Butterworth & Co. (Publishers) Ltd., London, 1955: pp. 375. 55s.

IN the foreword to this book it is said that the twenty-one chapters are essays in clinical research. Most are reports on work which is in progress or has been recently concluded. All but three are British in origin, indicating the growing interest in this field, an interest perhaps more vivid in Britain than anywhere else in Europe.

In the first chapter, HOPKINS criticizes a medical training which ill prepares the doctor for the type of work that confronts him daily. He regrets the lengthy period spent on the study of detailed anatomy, interfering as he claims with the more important study in the physiology department. And even here reference is rarely made to the physiological responses of emotion. "The effects of the emotions of fear and anxiety on human physiology may become all too apparent to the candidate sitting any part of his medical examinations, yet they pass unremarked." He goes on to describe his progression from being a "symptom-stopper," to developing insight into the emotional background in many diseases. He describes the excellent opportunities the general practitioner has for the study of patients as people, and people as they really are. It is stimulating to realize from HOPKINS's work that there are still possibilities for the family doctor to carry out important psychotherapeutic work, even if it cannot be denied that his changed social position militates against his practice of this type of work.

In the second contribution TODD describes the evolution of the psychosomatic concept and its revival in a different form at the present time. His article is characterized by a critical sense, and he discusses why it is all too easy to reach the wrong conclusion that organic diseases are caused by emotional disturbances. He also points out the lack of good evidence in favour of the view that the

arteriosclerotic disorders or rheumatoid arthritis should be considered as psychosomatic. One is inclined to be sympathetic with the author when he writes that the most that can be said is that emotional factors are in some cases of some relevance. But when he mentions that many of the subjects of duodenal ulcer appear to be stable and phlegmatic, and absolutely denies that the relapses of their disease have followed mental stress, pointing out that people of highly nervous temperament who have suffered repeated psychological trauma may live to an advanced old age free of this condition, one cannot agree with him in looking upon these observations as arguments against the psychosomatic theory. He appears somewhat too pessimistic as to the usefulness of superficial psychotherapy in duodenal ulcer. But in spite of his critical attitude, TODD advocates the emotional origin of many disorders, or bodily symptoms, and holds the view that the period a few decades ago, when so many symptoms of this kind were wrongly attributed to organic disease, could be described as "the black chapter of medicine."

One section of his paper deals with the effect of bodily disease on the emotions, and describes how different individuals develop quite different modes of reaction. A purely organic diagnosis is very often incomplete, and may be positively misleading, whilst the treatment of those with chronic benign organic disease should sometimes be determined as much from psychological considerations as by the identification of the organic lesion. This contribution by TODD contains many of the rules which must be adopted by doctors, if therapy is to succeed, and although he states that many of the views expressed by him are no more than elaborated common sense, nevertheless they are extremely important and are in need of an exposition such as his.

O'NEILL then goes on to deal with the important relationships between doctor, patient, and student. Most doctors leaving their medical school have only been taught the mechanistic view of medicine. They have been taught that disease is an occurrence in the organism, not a reaction of organism to environment. And the student is left to discover the rest for himself. O'NEILL puts the questions: how, then, is the student to learn, and what must he learn? For the second question he gives some guidance by means of the bibliography at the end of the volume. He also gives an outline of how practical studies could be performed, and he critically discusses the advantages and prejudices of different methods. In all his considerations, the interplay of emotional reactions and the resistances in the individuals concerned, doctor, patient, and student, are taken into account. This paper deserves to be studied by a very wide range of doctors and especially all those concerned with the teaching of medicine.

Then follows a variety of topics. MACKEITH treats the psychosomatic approach in paediatrics; CAMERON and LEYS repeat what is essentially a previous publication (on infantile acrodynia); APLEY and NAISH do likewise (on limb pains in children). There is a study of the psychological and social aspects of Sydenham's chorea in 42 children, by WALKER, who unfortunately fails to use a control group, and does not seem to be acquainted with recent work on the EEG in rheumatic fever. NYMAN's (1953) observations speak strongly in favour of the opinion that general and local changes in the brain very often form a part of the acute rheumatic process, even without a clinical picture of brain disease. It is tempting to suggest that such changes are really causal to a later developing chorea.

The report by GROEN and BASTIAANS on their studies of thirty-three patients with ulcerative colitis is a major contribution to this volume. Their long-term observations on personality structure, emotional conflict situations, and the effects of psychotherapy in these cases are characterized by a careful critical sense. The paper therefore must be regarded as highly authoritative. It can, in fact, be regarded as one of our main sources of knowledge in this field. The knowledge obtained has been used by the authors in formulating some important rules in the management of the patients; rules that proved useful as guiding principles in a supportive type of psychotherapy which was followed by a marked improvement, or a clinical cure, in thirty out of the thirty-three patients. One is grateful to the authors for what they have given here. The paper is indispensable for everyone dealing with the disease in question. Their article on bronchial asthma is likewise excellent. Here they summarize the arguments and counter-arguments for the allergenic versus psychogenic aetiology of bronchial asthma. On the basis of their own extensive observations they arrive at an integrated concept of aetiology, which may form a bridge between the psychogenic and somatic theories. They express their view in the following sentence. "Asthma allergens can be considered as substances to which the patients have become conditioned during a contact coincident with a state of emotional tension, which was subjectively experienced as a feeling of oppression." The presentation of evidence in

favour of this concept is very impressive, and it is difficult for the reader to avoid the idea that here, indeed, the authors are nearer to the truth than anyone else. It is also very interesting to note that they have succeeded in improving their treatment by using a combination of ACTH and group psychotherapy.

Another interesting contribution is that of NORTON and HALL-SMITH, who deal with the psychiatric view of skin disorders. They give a valuable and critical survey of the literature, and in addition present their experiences of a random sample of skin patients. As nearly all previous work has been based on series of highly-selected cases, their results are of great interest, even if it is true that their own series is not quite unselected. The paper can be recommended, above all because of the critical summing up of studies hitherto made in this field, although it does not include observations recently reported by some psycho-analysts.

A particularly interesting contribution to this reviewer is that with the title "Constitutional Aspects of Psychosomatic Medicine," by R. W. PARNELL. He presents the outlines of the somatotyping system of SHELDON, together with his results obtained by using this method in different groups with mental or psychosomatic disorders. Unfortunately, the series is very small and heterogeneous, making it difficult to evaluate the figures. The title of this contribution is not adequate, as it does not cover more than a small fragment of the field. The author does not quote any of the recent publications and he does not mention that there are other, recently elaborated methods, characterized by a higher degree of objectivity, making it possible to analyse not only the outer configuration of the body but also its structure (LINDEGARD, 1953). The article cannot be said to reflect the actual standpoint of this type of research, but is of some value because of the comprehensive description of the Sheldonian system.

There are further chapters on thyrotoxicosis by WITTKOWER and MANDELBROTE; on hypertension by HAMBLING; and on a variety of miscellaneous subjects, ranging from music and migraine to anxiety and muscle tension.

In the last three chapters a survey of some psychotherapeutic approaches is given. MARKILLIE deals with group psychotherapy, KLEIN with analytic therapy and SHORVON with abreaction therapy. In each of these papers the theoretical background, indications, procedure, and prejudices are discussed. It is rightly pointed out that any definite conclusions as to results for the moment must be premature; but that we can regard these procedures as important research instruments making it possible to arrive at a rational understanding of psychosomatic illnesses. This in turn could be thought to facilitate the development of more effective methods of treatment as well as preventive measures.

The value of this volume as a whole is considerably increased as the papers collected are followed by extensive references to the literature. At the end of the book the editor gives a sample of current psychosomatic works mainly arranged according to organ systems. He also briefly comments upon some of these. Of course it is a difficult task, and much of a personal matter, to make a proper selection of this kind. In the reviewer's opinion the bibliography includes several works of minor importance, while some of the major contributions are lacking. Works on psycho-physical relationships, works on the epidemiology of disease, or those representing a differential psychological approach to psychosomatic disorders are not included, although there are several with an important bearing on these problems.

With very few exceptions this collection of papers may be recommended to all doctors who are feeling in need of widening their concepts of human disease. Even if the book does not attempt to cover the entire field of medicine, in some sectors it brings the reader up to the present-day level of our basis for conceiving many illnesses as the result of disharmony between man and his world.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 177 to 185. Pergamon Press Ltd., London

CHANGES IN URINARY NITROGEN AND ELECTROLYTE EXCRETION DURING STRESSFUL LIFE EXPERIENCES, AND THEIR RELATION TO THYROID FUNCTION*

B. S. HETZEL, M.D.,†‡ W. W. SCHOTTSTAEDT, M.D.,†
W. J. GRACE, M.D., and H. G. WOLFF, M.D.

(With the technical assistance of ALBA PLESCIA, JOHNIE KIAH, and JOHN M. WHITTINGTON)

IN previous reports from this laboratory, changes in serum protein-bound iodine (PBI) and general metabolism associated with certain responses to stressful life experiences have been described (HETZEL *et al.*, 1952, 1956). These changes consisted of elevation of serum PBI, increases in oxygen consumption with fall in nonprotein RQ, with increases in urinary nitrogen excretion and simultaneous diuresis within an hour of the application of a stimulus evoking feelings of dread, apprehension, or horror.

However, elevation of serum PBI was not constantly observed in association with these metabolic changes, while other studies have revealed two instances in which elevation of serum PBI with stress has not been accompanied by elevation of serum butanol-extractable-iodine (BEI) (MAN *et al.*, 1951), as would be expected if the elevation was due to the thyroid hormone. Hence, similar studies have been carried out in hypothyroid subjects and the changes compared in order to evaluate better the role of the thyroid. Particular attention has been paid to the changes in serum PBI and in total nitrogen excretion, but opportunity has also been taken to evaluate similarly the role of the thyroid in the coincident increases in sodium and potassium excretion also observed under these conditions (SCHOTTSTAEDT *et al.*, 1956). A similar comparison has also been made between the response to the intravenous injection of 1 mg 3-5-3′-tri-iodothyronine in a euthyroid and a hypothyroid subject to assist in the interpretation of the differences that were observed. A preliminary communication on these data has already appeared (HETZEL *et al.*, 1954).

METHOD

The methods used in this type of investigation have been described previously (HETZEL *et al.*, 1952, 1956). Euthyroid and hypothyroid subjects from the New York Hospital were studied. The diagnosis of hypothyroidism was made with the aid of determinations of serum cholesterol, serum protein-bound iodine, and basal metabolic rate. Particular attention was paid to the role of stressful life situations in relation to the patient's symptoms. Subsequently, in the laboratory, such information was used to produce a stressful situation under experimental conditions. On occasions, advantage was taken of the occurrence of "spontaneous" stressful situations, e.g. the laboratory situation itself was stressful to some patients.

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The observations were made during the morning hours between 0900 and 1300 with the subjects in the post-absorptive state and without fluid-intake overnight. Urine specimens were collected over periods of approximately an hour before, during, and after the stressful period. Adequacy of collection was checked by determination of creatinine excretion, using a modification of the method of BONSNES and TAUSSKY (1954). Determinations of total nitrogen excretion were made, using a modified micro-Kjeldahl method (KOCH and MCMEEKIN), while determinations of sodium and potassium were carried out, using the Barclay flame photometer. In addition, urinary chloride was determined by the method of SENDROY (1939).

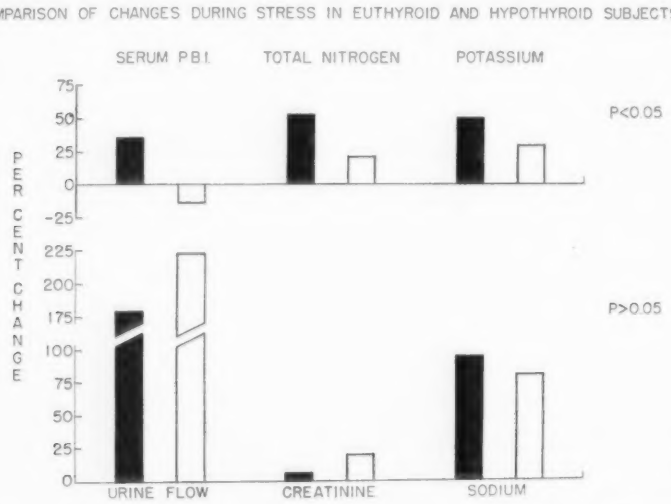

FIG. 1.—Comparison of changes in serum PBI, total nitrogen, urine flow, sodium, potassium, and creatinine excretion during stress in euthyroid subjects (black columns) and hypothyroid subjects (white columns).

Serial blood specimens at the beginning and end of each period were also taken for determination of serum protein-bound iodine (PBI) by the alkaline ash method of BARKER *et al.* (1951). The standard deviation of a mean of two duplicates in the range 3–10 gamma per cent was 0·8 gamma, which meant that a change of $\pm 2{\cdot}2$ gamma per cent was significant ($P < 0{\cdot}05$), assuming a normal distribution. Recoveries of thyroxin added to serum have averaged 87%.

RESULTS

1. *Changes During Stressful Life Experiences.*

Changes in serum PBI, urine flow, and excretion of total nitrogen, sodium, potassium, and creatinine in the two groups of subjects are summarized in Table 1, while Fig. 1 shows graphically a comparison between the mean changes (expressed as percentages of the mean initial level) in the two groups. Some of these studies have been described in the previous paper and will not be described again here. However, all these subjects reacted to the stressful stimuli with predominant feelings of dread and apprehension in association with diuresis (HINKLE *et al.*, 1951; SCHOTTSTAEDT *et al.*, 1956).

In the euthyroid groups (thirteen subjects) initial serum PBI values varied between 4·0 and 7·7 gamma per cent, with the exception of an unusually low value of 2·0 gamma per cent in H. G., who was clinically euthyroid. Half these subjects had essential hypertension.

In the hypothyroid group (five subjects) initial values of serum PBI varied between 2·8 and 8·0

TABLE 1.— CHANGES IN SERUM PBI, URINE FLOW, TOTAL NITROGEN, SODIUM, POTASSIUM, AND CREATININE EXCRETION DURING STRESSFUL LIFE EXPERIENCES

Subjects No.	Name	Age	Sex	S.A.	Serum PBI (gamma %) Before	After	Δ	Urine flow (cc/min) Before	After	Δ	Total nitrogen (mg/min) Before	After	Δ	Sodium (μeq/min) Before	After	Δ	Potassium (μeq/min) Before	After	Δ	Creatinine (mg/min) Before	After	Δ
(a) Euthyroid Subjects																						
1	I. G.(1)	40	M	1·97	4·6	10·4	+5·8	0·93	2·40	+1·47	8·0	14·2	+6·2	73	158	+85	66	85	+19	1·27	1·12	−0·15
2	I. G. (2)	40	M	1·97	5·9	5·5	−0·4	0·76	2·26	+1·50	8·1	14·2	+6·1	99	195	+96	41	86	+45	0·87	1·16	+0·29
3	H. G.	42	F	1·84	2·0	5·8	+3·8	1·71	1·71	+1·00	7·5	12·6	+5·1	131	383	+252	37	44	+7	1·50	1·71	+0·21
4	M. P.	42	M	2·0	6·4	7·4	+1·0	0·84	2·58	+1·74	7·8	11·3	+3·5	66	94	+28	70	80	+10	1·08	1·20	+0·12
5	R. S.	45	F	1·57	4·0	5·0	+1·0	0·78	2·74	+1·96	5·6	10·5	+4·9	158	287	+129	37	52	+15	1·04	0·91	−0·13
6	E. B.	57	F	1·63	4·8	4·6	−0·2	0·89	2·08	+1·19	4·7	8·5	+3·8	162	191	+29	28	46	+18	0·52	0·46	−0·06
7	K. M.	38	F	1·45	3·1	3·2	+0·1	1·19	4·74	+3·55	7·1	10·0	+2·9	93	180	+87	27	49	+22	0·69	0·76	+0·07
8	A. T.	50	F	1·40	6·6	6·3	−0·3	0·82	3·00	+2·18	6·3	6·3	0·0	138	228	+90	55	108	+53	0·62	0·63	+0·01
9	M. H.	48	F	1·90	6·7	5·7	−1·0	1·00	4·60	+3·60	2·2	3·7	+1·5	86	158	+72	28	60	+32	0·44	0·66	+0·22
10	E. P.	48	F	2·20	7·7	6·2	−1·5	0·74	1·20	+0·46	6·0	7·4	+1·4	102	182	+80	41	57	+16	1·14	1·44	+0·30
11	F. K.	63	F	1·73	6·0	3·9	−2·1	0·83	1·22	+0·39	5·2	6·6	+1·4							0·52	0·71	+0·19
12	W. S.	34	M	1·83	4·1	7·2	+3·1	0·84	1·70	+0·86				174	216	+42	92	103	+11	1·02	0·68	−0·34
13	S. G.	37	F	1·67	4·8	8·8	+4·0	0·65	1·87	+1·22				67	364	+297	47	96	+49	1·00	0·86	−0·14
14	W. G.	36	M	1·92	4·2	10·5	+6·3	0·68	1·04	+0·36				108	194	+86	59	91	+32			
Mean				1·79	5·1	6·5	+1·4	0·84	2·37	+1·53	6·2	9·5	+3·3	112	218	+106	48	73	+25	0·90	0·95	+0·05
(b) Hypothyroid Subjects																						
1	M. C.	40	F	1·64	8·0	7·6	−0·4	1·14	2·80	+1·66	2·7	2·6	−0·1	60	95	+35	30	40	+10	0·61	0·84	+0·23
2	M. B. (1)	28	F	1·55	2·8	2·8	0·0	0·70	4·50	+3·80	4·7	7·0	+2·3	55	54	−1	31	33	+2	0·93	0·83	−0·10
3	M. B. (2)	28	F	1·55	4·8	4·4	−0·4	0·50	1·21	+0·71	4·9	6·0	+1·1	116	128	+12	15	17	+2	0·70	0·99	+0·29
4	A. K.	36	F	1·66	5·7	3·2	−2·5	1·05	3·40	+2·35	5·2	4·8	−0·4	44	80	+36	28	35	+7	1·12	1·47	+0·35
5	H. P.	53	F	1·82	2·6	2·6	0·0	0·67	2·41	+1·74	4·5	6·5	+2·0	148	422	+274	55	72	+17	0·67	0·72	+0·05
6	J. A.	59	M	1·89	1·6	1·4	−0·2	0·81	1·74	+0·93	4·8	5·9	+1·1	99	174	+75	64	93	+29	1·08	1·25	+0·17
Mean				1·69	4·3	3·7	0·6	0·81	2·67	+1·86	4·5	5·5	+1·0	87	159	+72	37	48	+11	0·85	1·02	+0·17
P*				N.S.	<0·5		<0·15	N.S.		N.S.	<0·05		<0·05	<0·17		<0·10	<0·25		<0·05	N.S.		N.S.

Δ Difference between levels before and after stressful stimulus.
P* Probability using the rank test (WHITE, 1952) for comparison of euthyroid and hypothyroid groups.
N.S. Not significant.

gamma per cent, with the exception of J. A., who was untreated and had a level of 1·6 gamma per cent. Of these subjects, M. C. and M. B. were clinically euthyroid with a normal blood cholesterol and were taking, respectively, daily doses of 120 mg and 90 mg of desiccated thyroid. Patient H. P. was not yet euthyroid clinically; her blood cholesterol was 218 mg per cent (having previously been 368 mg per cent). Patient A. K. had been treated for a month, with considerable improvement. Two of these subjects (M. C. and H. P.) had essential hypertension.

(a) *Changes in serum PBI.* In the euthyroid group, significant elevations in serum PBI ($P < 0{\cdot}05$) were observed in five of the fourteen studies, while a significant fall was observed in one instance (F. K.). In the hypothyroid group (six studies), elevation was observed in no instance; a significant fall occurred in one instance (A. K.). The difference between the two groups did not reach statistical significance ($P < 0{\cdot}15$).

(b) *Changes in urine flow.* In the euthyroid group, initial urine flows were 0·65 to 1·19 cc/min and 0·50 to 1·05 cc/min in the hypothyroid group. Increases following stressful stimuli varied between 0·36 and 3·6 cc/min in the euthyroid and 0·93 and 3·8 cc/min in the hypothyroid group. There was no significant difference between the two groups in either the initial levels or the changes.

(c) *Changes in total nitrogen excretion.* Initial levels of total nitrogen excretion varied between 2·2 and 8·1 mg/min in the euthyroid group and 2·7 and 5·2 mg/min in the hypothyroid group. These differences were significant ($P < 0{\cdot}05$). Absolute increases in the euthyroid group varied between 0 and 6·2 mg/min (0 and 87·5%), with a mean of 3·3 mg/min (53%), while in the hypothyroid group, absolute increases varied between −0·4 and 2·3 mg/min (−7·7 and 48·9%), with a mean of 1·0 mg/min (22%). Both absolute and per cent increases in the two groups were significantly different ($P < 0{\cdot}05$). The comparatively small increases in total nitrogen excretion in M. H., E. P., and F. K. were associated with less psychological evidence of stress than in any of the other subjects in either group.

(d) *Changes in sodium excretion.* In the euthyroid subjects, initial levels varied from 66 to 174 μeq/min, with increases varying from 28 to 297 μeq/min (17·9 to 443%), with a mean of 106 μeq/min (95%). In the hypothyroid subjects, initial levels of sodium excretion varied between 44 and 148 μeq/min (not significantly different from the range of initial values in euthyroid subjects), while increases ranged from −1 to 274 μeq/min (−1·8% to 185%), with a mean of 72 μeq/min (83%). These differences were only significant at the 10% level. Very large changes (185–443%) in sodium excretion occurred in three hypertensive subjects, two of whom were euthyroid and one hypothyroid. However, comparison of the changes in all the hypertensive subjects with those in normotensives in the euthyroid group showed no significant differences.

(e) *Changes in potassium excretion.* In euthyroid subjects, initial levels of potassium excretion were in the range 27 to 92 μeq/min, increases varying from 7 to 53 μeq/min (8·4% to 114·3%), within a mean of 25 μeq/min (52%). In the hypothyroid subjects, the initial range was 15 to 64 μeq/min (not significantly different from the initial range in euthyroid subjects), while increases varied from 2 to 29 μeq/min (6·4% to 45%) with a mean of 11 μeq/min (30%). These differences were significant ($P < 0{\cdot}05$).

Inspection of the data will show that in general the smaller percentages of increase in sodium and potassium were associated with a higher initial level of excretion.

(f) *Changes in creatinine excretion.* Similar initial levels and changes in creatinine excretion occurred in both groups, the change consisting generally of a small increase (Table 1). Recalculation of all the data in Table 1 on the basis of the creatinine excretion, i.e. converting all excretion rates to that corresponding to a creatinine excretion of 1 mg/min, did not significantly affect the findings stated above.

We may conclude from these results that, under similar conditions of stressful life experiences, with diuresis, hypothyroid subjects excrete significantly smaller amounts of nitrogen and potassium and to a less extent sodium than do euthyroid subjects.

2. *Changes Following Tri-iodothyronine*

In order to investigate the possibility that these differences were due to a difference in responsiveness to thyroid hormone in the two groups, the effects of 1 mg 3:5:3′-tri-iodothyronine given by intravenous injection in a euthyroid and an untreated hypothyroid subject with classical myxoedema are compared. The data on urine flow, total nitrogen, sodium, potassium, chloride, and creatinine excretion are summarized in Table 2. The data on total nitrogen excretion are shown graphically in Fig. 2.

The data indicate a striking increase in nitrogen excretion in both cases in the 8–10-hour period after injection. Determinations on individual hourly specimens showed that this increase was apparent at the ninth hour in both cases. In the euthyroid subject, the increase was from 9·7 to 13·4 mg/min (38·1%); in the hypothyroid subject from 5·6 to 11·2 mg/min (100%). The increases in electrolyte excretion were also proportionately greater in the hypothyroid subject. These changes were associated with an increase in creatinine excretion in both cases (Table 2).

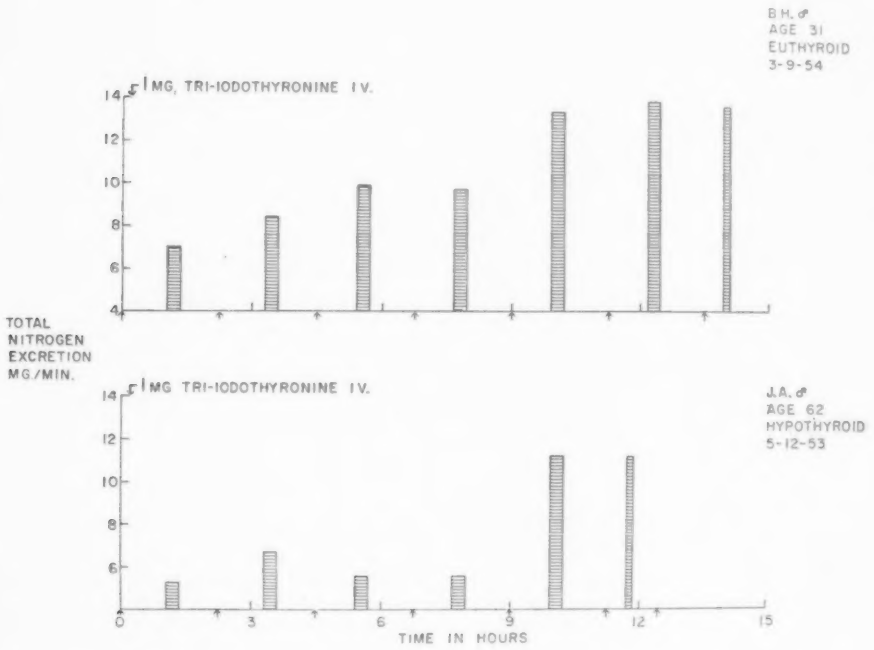

FIG. 2.—Comparison of changes in total nitrogen excretion following intravenous tri-iodothyronine in a euthyroid subject and a hypothyroid subject.

DISCUSSION

In the previous paper, the significance of the increases in nitrogen excretion observed in euthyroid subjects during stressful life experiences has been discussed. In brief, these changes have been found to be associated with increases in oxygen consumption with fall in nonprotein RQ, suggesting increased fat catabolism. They are not associated with a fall in blood nonprotein nitrogen; they are not solely dependent on increases in urine flow and are not associated with significant increase in creatinine excretion. It seems reasonable, therefore, to conclude that they are due to increased protein breakdown. The increases in potassium excretion are greater than would be accounted for by the increase in nitrogen excretion, but this is usually observed during stress in animals (SELYE, 1946) and in man (MOORE, 1950). As previously pointed out (HETZEL *et al.*, 1956), the pattern of metabolic changes observed is similar to that described following surgical trauma (CUTHBERTSON, 1942; MOORE, 1950) and infections (GROSSMAN *et al.*, 1945).

There are several possible interpretations of the cause of the smaller changes in the hypothyroid subjects in these studies.

TABLE 2.—COMPARISON OF EFFECT OF 1 MG 1-TRI-IODOTHYRONINE BY INTRAVENOUS INJECTION IN A EUTHYROID SUBJECT AND A HYPOTHYROID SUBJECT

		Time in hours after injection						
		0*	2*	4*	6*	8*	10*	12*
Serum PBI gamma %	E	4·4	7·8	5·3	—	4·6	—	—
	H	1·0	4·6	3·2	—	2·5	—	—
Urine flow cc/min	E	0·29	0·41	1·50	0·59	0·68	0·73	0·85
	H	0·82	0·65	0·73	0·66	1·59	2·51	3·33
Total nitrogen mg/min	E	5·7	7·0	8·4	9·9	9·7	13·4	13·9
	H	5·7	5·3	6·7	5·6	5·6	11·2	11·2
Sodium μeq/min	E	30	65	86	129	129	163	176
	H			74‡		91†		147†
Potassium μeq/min	E	48	60	72	80	109	53	66
	H			57‡	81*	81†		96†
Chloride μeq/min	E	77	121	142	138	156	124	134
	H	90	69	77	54	59	105	110
Creatinine mg/min	E	1·46	1·53	1·44	1·48	1·47	1·77	1·68
	H	1·19	1·32	1·02	1·13	1·27	1·42	1·13

* In case of urinary excretion, includes preceding 2-hour period.
† Includes preceding 4-hour period.
‡ Includes preceding 6-hour period
E Euthyroid
H Hypothyroid

(1) It might be suggested that the hypothyroid subjects did not fully experience the stimulus as did the euthyroid subjects, owing to cerebral cortical impairment associated with inadequate replacement therapy. Against this possibility can be cited the fact that these hypothyroid subjects showed an increase in urine flow of similar degree to the euthyroid group, indicating that the stimulus was perceived,

(2) It might be suggested that the metabolic state in the hypothyroid subjects was such that they were unable to respond even though the stimulus was perceived. Against this explanation may be cited the well-known fact that hypothyroid subjects are more sensitive to thyroid hormone than euthyroid subjects (THOMPSON *et al.*, 1929; ASPER *et al.*, 1953). This has been confirmed by the results of the comparison of the effects of 1 mg 1-tri-iodothyronine in an untreated hypothyroid and a euthyroid subject in this study. Hence the fact that not all the subjects were euthyroid would tend to

make the differences in the opposite direction to that observed, i.e. greater changes in the hypothyroid subjects than in normals.

(3) It might be suggested that the differences in the responses are due to differences in the function of other endocrine glands such as the adrenal cortex, which is known to be sometimes impaired in hypothyroidism (PAULL and PHILLIPS, 1945). Studies of seventeen hydroxycorticosteroid excretion have been carried out in some of these experiments, and have been reported elsewhere (HETZEL *et al.*, 1955). These show similar initial levels and similar increases in corticoid excretion in euthyroid and hypothyroid subjects maintained on desiccated thyroid.

In view of these considerations, it is suggested that the differences in the changes may depend on differences in the ability of the thyroid gland to increase its output of thyroid hormone. The finding of elevation of serum PBI in five of the euthyroid subjects but not in the hypothyroid subjects is consistent with this interpretation. However, for reasons which have already been stated above, no final conclusion can be drawn from this data at present.

There is evidence from animal studies that the thyroid may exert a regulatory role in the increased nitrogen excretion following burns (SELLERS *et al.*, 1950; WASE *et al.*, 1953; GRIBBLE and PETERS, 1951). Evidence of the importance of the thyroid in the mobilization of nitrogen during fasting is also available (WHITE and DOUGHERTY, 1947). On the other hand, the "permissive" role of the adrenal cortex in the increased excretion of nitrogen, sodium, and potassium during stress has been well documented in animals (INGLE *et al.*, 1947; ENGEL, 1952), and has been confirmed under the conditions of these experiments in a totally adrenalectomized subject maintained on cortisone and desoxycorticosterone (HETZEL *et al.*, 1955).

The possible mechanism of the participation by the thyroid in this metabolic response is not clear. It is clear that thyroxin could not be effecting these hour-to-hour changes in nitrogen excretion, as its effects are not apparent for forty-eight hours (BYROM, 1934; ASPER *et al.*, 1953; RAWSON *et al.*, 1953). The data indicating that similar effects of intravenous 3:5:3′-tri-iodothyronine on nitrogen and electrolyte excretion are apparent less than ten hours after injection, would make it seem more likely that this agent was responsible. Recent studies (HETZEL and PLESCIA, 1955) demonstrating increases in urinary nitrogen, sodium, and potassium excretion within 4–6 hours of the intramuscular administration of thyrotropic hormone suggest the possibility of a rapidly acting agent coming from the thyroid. Further work is in progress to decide whether or not this agent is tri-iodothyronine. However, it is of interest that the differences in time-relationships between these effects of TSH and stress is similar to those found for the effects of ACTH and stress on nitrogen metabolism in rats by ENGEL (1952). Presumably the stress response is accelerated by a combination of endocrine and metabolic changes in contrast to the effect of a single hormone (ENGEL, 1949, 1952).

MILES and DE WARDENER (1953) found greater increases in salt excretion in ten hypertensive than in ten normotensive women associated with emotional stress following catheterization. This has not been found in the present study, though the biggest increases were all observed in hypertensive subjects. These authors concluded from their data that diminished tubular reabsorption was more likely responsible than increase in glomerular filtration rate; and that this may have resulted from sudden output of a salt-losing hormone or direct nervous inhibition of tubular function.

From the evidence presented here, it is suggested that the thyroid hormone may be one important factor in these changes.

SUMMARY AND CONCLUSIONS

(1) Changes in serum PBI and urine flow, and in total nitrogen, sodium, and potassium excretion have been compared under similar conditions during stressful life experiences in euthyroid and hypothyroid subjects.

(2) Increases in nitrogen and potassium excretion were significantly greater ($P < 0{\cdot}05$) in the euthyroid group, although there was no difference in the increases in urine flow. Increases in sodium excretion and serum PBI were greater in the euthyroid group, but the differences were not statistically significant.

(3) Greater percentage changes in total nitrogen and electrolyte excretion were observed in a hypothyroid than in a euthyroid subject when each was given 1 mg l-tri-iodothyronine intravenously.

(4) The findings suggest that the thyroid may be participating in a rapid metabolic adjustment, but the mechanism involved is not clear from existing knowledge of the thyroid hormone.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 186 to 202. Pergamon Press Ltd., London

GENERAL METABOLIC CHANGES DURING STRESSFUL LIFE EXPERIENCES IN MAN*

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PREVIOUS studies from this laboratory (HETZEL *et al.*, 1952) have suggested that the thyroid gland participates in certain responses to acute stressful life experiences. In view of the role of the thyroid in the control of metabolic rate, changes in general body metabolism would be expected if this were true. To explore this possibility, determinations of gaseous exchange and urinary total nitrogen excretion were carried out before, during, and after experimentally induced stressful life experiences in the laboratory.

In the main, these studies were made on euthyroid subjects, but studies in hypothyroid and adrenalectomized subjects were also included in order to evaluate the role of the thyroid and adrenal glands under these conditions. A preliminary report has already appeared (HETZEL *et al.*, 1953).

METHOD

Subjects from the New York Hospital were studied by means of a full medical history, physical examination, and appropriate laboratory investigation.

Evidence concerning behaviour and personality features was obtained by taking a detailed biography. Particular attention was paid to areas of significant interpersonal conflict, periods of life stress being correlated with periods of illness.

In general, the experiments consisted of a preliminary period, during which the patient was diverted and relatively calm. After approximately one hour a discussion was initiated. This discussion concerned topics in the patient's life which were known to be stressful. Finally, after this interview, which lasted about one hour, an attempt was made to re-establish a feeling of security in the patient. During each of these periods the attitude and feelings of the patient were ascertained by direct questions and observation. On another occasion, similar studies were carried out while the subjects were maintained in a relatively tranquil state throughout a three-hour period. All the experiments were made during the morning hours, with the subjects in the post-absorptive state, without intake of fluid.

Determination of gaseous exchange was carried out by collection of expired air over 3-min periods in a Tissot spirometer during the first and third observations, after a 10-min rest-interval and three 3-min flushing-out periods. In the middle-observation period, a similar collection was made with the Douglas bag. The oxygen and carbon dioxide concentrations of each sample of expired air and of a sample of room air were determined with the 0·5-cc. Scholander micro gas-analyser (SCHOLANDER, 1947), and calculations of oxygen and carbon dioxide exchange and respiratory quotient (RQ) were made, using the usual respiratory equations (PAPPENHEIMER, 1950). The nonprotein RQ (NPRQ) was also calculated. Studies during which large changes in ventilation occurred were excluded from this report.

Specimens of urine were collected on arrival at the laboratory and at the end of each of the three

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observation periods, which lasted approximately an hour each; the urine flow was expressed in cc/min. The total urinary nitrogen was estimated by a modification of the micro-Kjeldahl method (KOCH and MCMEEKIN, 1924), using a Coleman spectrophotometer, and was expressed in mg/min. Completeness of the collections was checked by determination of creatinine, using a modification of the method of BONSNES and TAUSSKY (1945).

Determinations of blood glucose (by a modification of the Folin-Wu method) and of *serum non-protein nitrogen* (Koch-McMeekin method) were made in a few experiments. Determinations of urinary sodium and potassium excretion will be reported in the subsequent paper (HETZEL *et al.*, 1956).

RESULTS

1. *Observations during a Steady and Relatively Tranquil State—Euthyroid Subjects*

The extent of variation of the aforementioned indices of metabolism in eight euthyroid subjects who were not interviewed, and who were in a relatively tranquil and steady state for a period of approximately three hours, is summarized in Table 1.

The initial levels of oxygen consumption varied from 151 to 220 cc/min, carbon dioxide elimination 125 to 170 cc/min, and ventilation (STPD*) 3·8 to 6·0 litres/min, and RQ 0·77 to 0·86, with the exception of subject F. L., in whom the carbon dioxide, RQ and ventilation values were all elevated. Initial levels of nitrogen excretion and urine volume (first period) varied from 4·7 to 10·9 mg/min and 0·38 to 0·98 cc/min, respectively. The RQ was more variable, due to the combination of slight alterations in oxygen and carbon dioxide exchange.

During a steady and relatively tranquil state, only small changes were observed. These data, after correction for a surface area of 1·73 sq. m., are summarized in Table 2. The change in oxygen consumption varied from −1 to +34 cc/min, and in carbon dioxide elimination from −11 to +36 cc/min. Little change in ventilation occurred (Table 1). Total nitrogen excretion and urine volume (except in subjects R. S. and I. G.) also remained relatively constant. In subjects I. G., E. B., and R. S., urine flow exceeded 1 cc/min in the first and/or the second periods. This was associated in I. G. and E. B. with evidence of considerable apprehension (described subsequently), and in R. S. with a migraine headache.

2. *Observations during Stressful Interviews—Euthyroid Subjects*

The results of these studies are shown in Tables 3 and 4, the differences between the first (initial) and second (stressful) periods are summarized in Table 6, corrections having been made for a surface area of 1·73 sq. m.

During the preliminary observation period, values for oxygen consumption ranged between 156 and 316 cc/min. Excluding subject E. P., an obese female weighing 100·7 kg, the range was 156–216 cc/min for oxygen consumption and 123–196 cc/min for carbon dioxide elimination. These findings are similar to those obtained when subjects were in a steady and tranquil state. The range of initial values for urine total nitrogen were 2·2–9·2 mg/min, and for urine volume 0·15–1·0 cc/min, similar to the values observed in controls during a steady state. Paired studies on the same subject were carried out in four instances (M. P., E. B., R. S., and I. G.).

On eight occasions, in eight subjects, diuresis in excess of 1 cc/min was observed during the period of stress (Table 3), whereas on seven occasions, in seven other subjects, no such diuresis occurred (Table 4).

* Standard temperature and pressure, dry.

TABLE 1.—GENERAL METABOLISM UNDER CONDITIONS OF RELATIVE TRANQUILLITY—EUTHYROID SUBJECTS

Subjects					Gaseous exchange STPD					Total nitrogen excretion					
No.	Name	Age	Sex	S.A.		First period	Second period	Third period	Δ		0	1	2	3	Δ
1	M. P.	42	M	1·95	O_2	198	206	211	+8	N	5·2	6·6	5·6	5·2	−1·0
					CO_2	170	158	177	−12	F	0·49	0·89	0·76	0·67	−0·13
					RQ	0·86	0·77	0·84	−0·09						
					V	4·6	4·4	4·5	−0·2						
2	R. S.	45	F	1·57	O_2	166	172	158	+6	N	7·1	11·8	7·5	7·0	−4·3
					CO_2	129	134	123	+5	F	0·84	2·78	1·17	1·14	−1·61
					RQ	0·78	0·78	0·78	0·0						
					V	3·9	4·0	3·6	+0·1						
3	E. B.	57	F	1·63	O_2	175	205	184	+30	N	7·4	6·2	7·8	4·2	+1·6
					CO_2	128	136	144	+8	F	1·21	0·98	1·34	0·67	+0·36
					RQ	0·73	0·66	0·78	−0·07						
					V	3·8	4·0	4·3	+0·2						
4	I. G.	40	M	1·97	O_2	210	249	208	+39	N	10·0	16·0	11·0	13·7	−5·0
					CO_2	173	178	164	+5	F	0·78	2·00	1·70	1·81	−0·30
					RQ	0·82	0·71	0·79	−0·11						
					V	4·4	4·4	4·1	0·0						
5	P. C.	54	M	1·61	O_2	190	189	176	−1	N	10·8	10·9	9·9	9·0	−1·0
					CO_2	146	135	137	−11	F	0·81	0·78	0·63	0·52	−0·15
					RQ	0·77	0·72	0·78	−0·05						
					V	5·5	5·1	4·9	−0·4						
6	M. J.	37	F	1·61	O_2	151	169	147	+18	N	4·3	4·7	4·0	5·5	−0·7
					CO_2	125	125	117	0	F	0·32	0·38	0·40	0·57	+0·02
					RQ	0·83	0·74	0·80	−0·09						
					V	4·2	3·5	3·6	−0·7						
7	F. L.	21	M	1·67	O_2	218	230	240	+12	N	6·1	5·7	3·4	3·4	−2·3
					CO_2	312	347	330	+35	F	0·63	0·70	0·39	0·40	−0·31
					RQ	1·43	1·50	1·38	+0·07						
					V	10·8	10·9	11·9	+0·1						
8	B. H.	30	M	2·24	O_2	220	243	231	+23	N	5·2	6·8	8·3	7·2	+1·5
					CO_2	168	199	186	+31	F	0·30	0·43	0·62	0·59	+0·19
					RQ	0·77	0·82	0·80	+0·05						
					V	6·0	6·2	6·0	+0·2						

Δ Difference between first and second periods (columns 1 and 2).
O_2 Oxygen consumption in cc/min.
CO_2 Carbon dioxide elimination in cc/min.
V Ventilation in litres/min.
STPD Standard temperature and pressure, dry.
N Total nitrogen in mg/min.
F Urine flow in cc/min.

During the period of stress associated with diuresis, increases in oxygen consumption from +12 to +85 cc/min were observed in association with minimal changes in carbon dioxide output and ventilation, with the exception of subject I. G. (Table 2). The RQ showed a fall in all but one case. The changes in urine flow were variable, because the diuresis was sometimes already noted in the first period. However, in spite of this, increases in nitrogen excretion (up to 4·0 mg/min) were observed

TABLE 2.—SUMMARY OF CHANGES IN GASEOUS EXCHANGE AND NITROGEN EXCRETION
(Corrected for S.A. 1·73 sq. m.)
Euthyroid Subjects

No.	Subject	ΔO_2	ΔCO_2	RQ	NPRQ	ΔN	ΔF
			A. During periods of relative tranquillity				
1	M. P.	+7	−11	−0·09	−0·12	−0·9	−0·12
2	R. S.	+7	+6	0·0	+0·02	−4·7	−0·77
3	E. B.	+32	+9	−0·07	−0·09	+1·7	+0·38
4	I. G.	+34	+4	−0·106	−0·16	−4·4	−0·26
5	P. C.	−1	+12	−0·05	−0·07	−1·1	−0·16
6	M. J.	+19	0	−0·09	−0·10	−0·7	+0·02
7	F. L.	+12	+36	+0·07	+0·03	−2·4	−0·32
8	B. H.	+17	+24	+0·05	+0·07	+1·2	+0·15
			B. During stressful life experiences. Reactions associated with diuresis*				
1	M. P.	+30	+1	−0·11	−0·16	+3·0	+1·51
2	R. S.	+25	+8	−0·08	−0·09	+3·3	+0·66
3	E. B.	+43	+13	−0·18	−0·24	+4·0	+1·26
4	I. G.	+85	+48	−0·14	−0·11	+1·5	−0·09
5	A. T.	+12	−9	−0·08	−0·11	0·0	+1·46
6	E. P.	+13	+7	+0·01	−0·01	−1·8	−0·13
7	H. G.	—	—	—	—	+4·8	+0·94
8	F. K.	—	—	—	—	−0·5	−0·20
P		>0·05	>0·05	>0·05	>0·05	<0·05	<0·05
			C. During stressful life experiences. Reactions without diuresis				
1	F. L.	+36	+46	+0·08	+0·11	+1·0	+0·90
2	M. L.	+35	+24	−0·02	−0·01	−1·9	+0·08
3	A. O.	+24	+18	−0·02	—	—	−0·09
4	I. K.	−5	−1	−0·01	+0·02	+0·7	+0·07
5	M. H.	+1	−6	−0·03	−0·03	−0·6	−3·5
6	M. F.	—	—	—	—	−2·3	−0·37
7	A. C.	—	—	—	—	+0·5	−0·08
P		>0·05	>0·05	>0·05	>0·05	>0·05	>0·05

Δ Difference between first and second periods (columns 1 and 2).
NPRQ Nonprotein respiratory quotient.
P Probability using a rank test (WHITE, 1952) compared with tranquil periods.
*Diuresis— Urine flow in excess of 1 cc/min in second period.

in all but two cases. No significant changes in the levels of blood nonprotein nitrogen (two cases) or blood glucose (three cases) were observed in association with these changes in gaseous exchange and nitrogen excretion. All these eight subjects reacted to the stimulus of the interview with mixed feelings, of which fear and dread were most prominent.

When no diuresis was observed in the middle period, changes in gaseous exchange, urine volume, and nitrogen excretion were no greater than in the studies carried out under conditions of relative tranquillity. These seven subjects reacted to the stressful

TABLE 3.—GENERAL METABOLISM DURING STRESSFUL LIFE EXPERIENCES: REACTIONS ASSOCIATED WITH DIURESIS—EUTHYROID SUBJECTS

Subjects					Gaseous exchange STPD					Total nitrogen excretion					
No.	Name	Age	Sex	S.A.		First period	Second period	Third period	Δ		0	1	2	3	Δ
1	M. P.	42	M	2·0	O_2	227	262	229	+35	N	6·1	7·8	11·3	6·0	+3·5
					CO_2	196	195	183	−1	F	0·59	0·84	2·58	1·1	+1·74
					RQ	0·86	0·75	0·80	−0·11						
					V	5·3	5·2	4·8	−0·1						
2	R. S.	45	F	1·57	O_2	156	177	166	+23	N	5·6	7·5	10·5	4·2	+3·0
					CO_2	135	142	140	+7	F	0·73	2·1	2·7	1·1	+0·6
					RQ	0·87	0·79	0·84	−0·08						
					V	4·2	4·3	4·5	+0·1						
3	E. B.	57	F	1·63	O_2	197	238	195	+41	N	5·2	4·7	8·5	3·4	+3·8
					CO_2	154	142	140	−12	F	0·99	0·89	2·08	0·61	+1·19
					RQ	0·78	0·60	0·72	−0·18						
					V	4·7	4·9	4·3	+0·2						
4	I. G.	40	M	1·97	O_2	183	280	235	+97	N	8·0	12·5	14·2	9·5	+1·7
					CO_2	176	231	219	+55	F	0·93	2·5	2·4	1·9	−0·1
					RQ	0·96	0·82	0·93	−0·14						
					V	5·1	6·3	6·4	+1·2						
5	A. T.	50	F	1·40	O_2	159	169	193	+10	N	6·3	5·6	6·3	3·6	+0·7
					CO_2	123	116	150	−7	F	0·82	1·82	3·00	0·96	+1·18
					RQ	0·77	0·69	0·78	−0·08						
					V	3·8	3·4	5·0	−0·4						
6	E. P.	48	F	2·20	O_2	316	332	328	+16	N	6·0	7·4	5·1	7·1	−2·3
					CO_2	241	250	246	+9	F	0·74	1·20	1·03	0·93	−0·17
					RQ	0·76	0·75	0·75	+0·01						
					V	6·6	6·8	6·7	+0·2						
7	H. G.	42	F	1·84						N	9·2	7·5	12·6	8·1	+5·1
										F	0·77	0·71	1·71	0·88	+1·00
8	K. F.	63	F	1·73						N	5·2	6·6	6·1	6·2	−0·5
										F	0·83	1·22	1·02	0·91	−0·20

Δ Difference between first and second periods (columns 1 and 2).
O_2 Oxygen consumption in cc/min.
CO_2 Carbon dioxide elimination in cc/min.
V Ventilation in litres/min.
STPD Standard temperature and pressure, dry.
N Total nitrogen in mg/min.
F Urine flow in cc/min.
Diuresis—Urine flow in excess of 1 cc/min in second period.

situation with mixed feelings, predominant among which were indecision, frustration, and conflict. Some examples will now be considered in detail.

A. *Reactions Associated with Diuresis*

Subject 1. M. P. (Figs. 1 and 2), a 42-year-old male, was asked to come to the laboratory for a check-up on his general condition. On arrival, he was noted to be apprehensive. During the first observation period his oxygen consumption was 227 cc/min, and nitrogen excretion 7·8 mg/min. In the second period, the patient's concern about the condition of his heart was discussed with him. He said, "I've been worried that nervousness may cause overaction and disease of my heart."

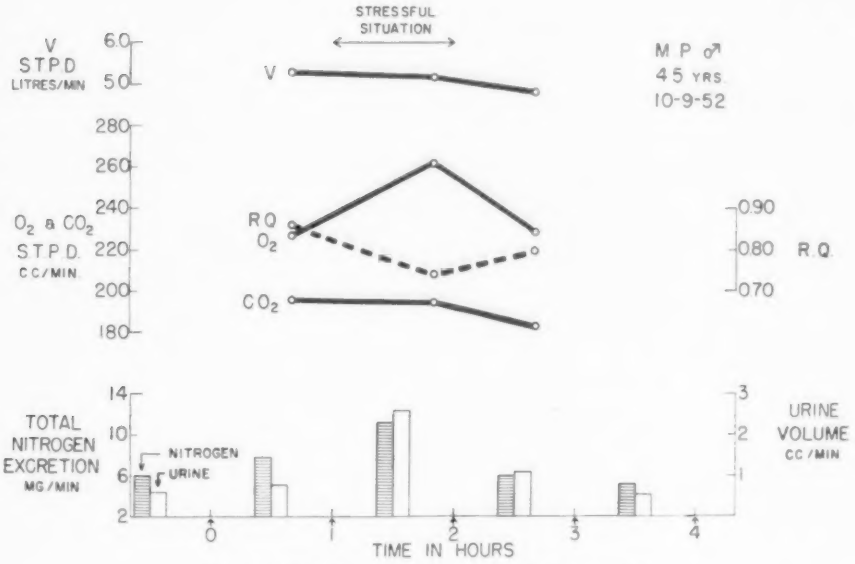

FIG. 1. Metabolic changes associated with a stressful situation in a euthyroid subject.

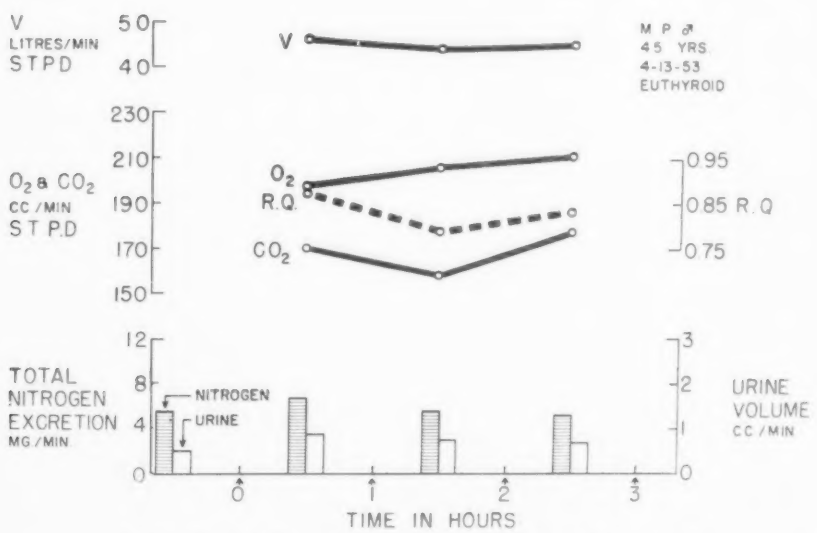

FIG. 2. Steady metabolic state during a period of relative tranquillity in the subject represented in Fig. 1.

TABLE 4.—GENERAL METABOLISM DURING STRESSFUL LIFE EXPERIENCES: REACTIONS ASSOCIATED WITH NO DIURESIS—EUTHYROID SUBJECTS

Subjects					Gaseous exchange STPD					Total nitrogen excretion					
No.	Name	Age	Sex	S.A.		First period	Second period	Third period	Δ		0	1	2	3	Δ
1	F. L.	45	M	2·11	O_2	261	305	278	+44	N	8·6	9·4	10·6	8·3	+1·2
					CO_2	183	239	256	+56	F	0·58	0·69	0·80	0·52	+0·11
					RQ	0·70	0·78	0·92	+0·08						
					V	5·8	7·7	7·93	+1·9						
2	M. L.	32	F	1·54	O_2	193	224	182	+31	N	2·8	5·9	4·2	8·2	−1·7
					CO_2	150	171	143	+21	F	0·15	0·25	0·32	0·40	+0·07
					RQ	0·78	0·76	0·79	−0·02						
					V	4·3	4·7	4·1	+0·4						
3	A. O.	36	M	1·95	O_2	186	213	231	+27	N	—	—	—	—	—
					CO_2	161	181	191	+20	F	0·67	0·70	0·60	0·55	−0·10
					RQ	0·87	0·85	0·83	−0·02						
					V	5·0	5·0	5·3	0·0						
4	I. K.	58	F	1·44	O_2	196	192	197	−4	N	2·2	4·1	4·7	6·4	+0·6
					CO_2	157	156	151	−1	F	0·25	0·44	0·50	0·72	+0·06
					RQ	0·80	0·81	0·77	−0·01						
					V	5·2	5·3	5·0	+0·1						
5	M. H.	48	F	1·90	O_2	235	236	227	+1	N	2·2	3·7	3·0	2·2	−0·7
					CO_2	177	170	189	−7	F	1·00	4·60	0·76	0·66	−3·84
					RQ	0·75	0·72	0·83	−0·03						
					V	6·6	6·7	6·6	+0·1						
6	M. F.	53	F	1·44						N	4·5	4·6	2·7	3·8	−1·9
										F	0·69	0·76	0·45	0·65	−0·31
7	A. C.	37	F	1·51						N	6·5	6·5	6·9	5·9	+0·4
										F	0·59	0·71	0·64	0·54	−0·07

Δ Difference between first and second periods (columns 1 and 2).
O_2 Oxygen consumption in cc/min.
CO_2 Carbon dioxide elimination in cc/min.
V Ventilation in litres/min.
STPD Standard temperature and pressure, dry.
N Total nitrogen in mg/min.
F Urine flow in cc/min.

The possibility of cardiac catheterization being carried out as a check on his cardiac condition was mentioned to him, and another physician made a physical examination with a rather tentative report. The patient became increasingly apprehensive at this point; his oxygen consumption was found to be 262 cc/min, but there was only a slight change in carbon dioxide elimination, so that the RQ fell from 0·86 to 0·75. His urinary nitrogen excretion rose to 11·3 mg/min over this period (from 7·8 mg/min). Later the patient was reassured as to the results of the test, indicating that his cardiac condition was sound and that cardiac catheterization was unnecessary; he accepted this readily. In the third period his oxygen consumption, RQ, and nitrogen excretion were found to have returned to their initial levels. Similar observations carried out six months later, during a relatively tranquil state, showed little variation in gaseous exchange or nitrogen excretion (Fig. 2); the levels of the various indices were approximately the same as those following reassurance in the first study.

Subject 2. E. B. (Figs. 3 and 4). Similar changes were observed in this 57-year-old woman. During the preliminary control period her oxygen consumption was 197 cc/min, carbon dioxide

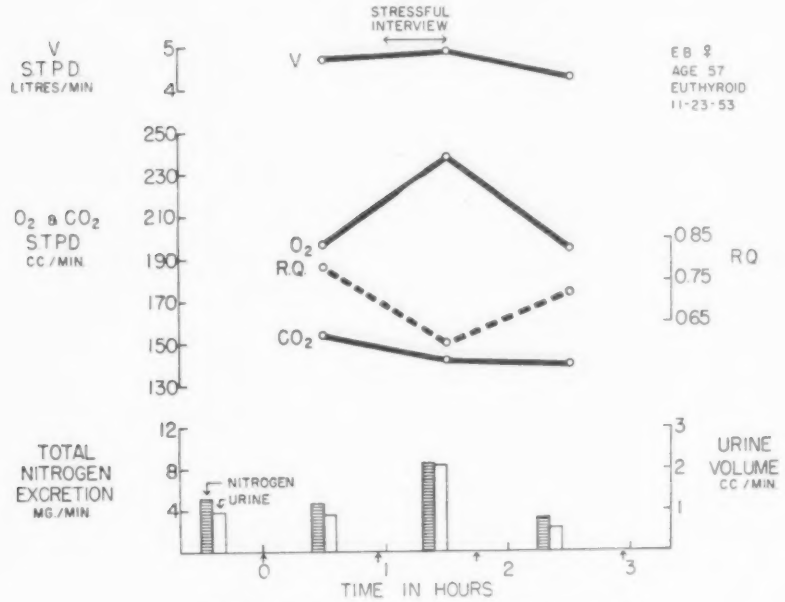

FIG. 3. Metabolic changes associated with a stressful interview in a euthyroid subject.

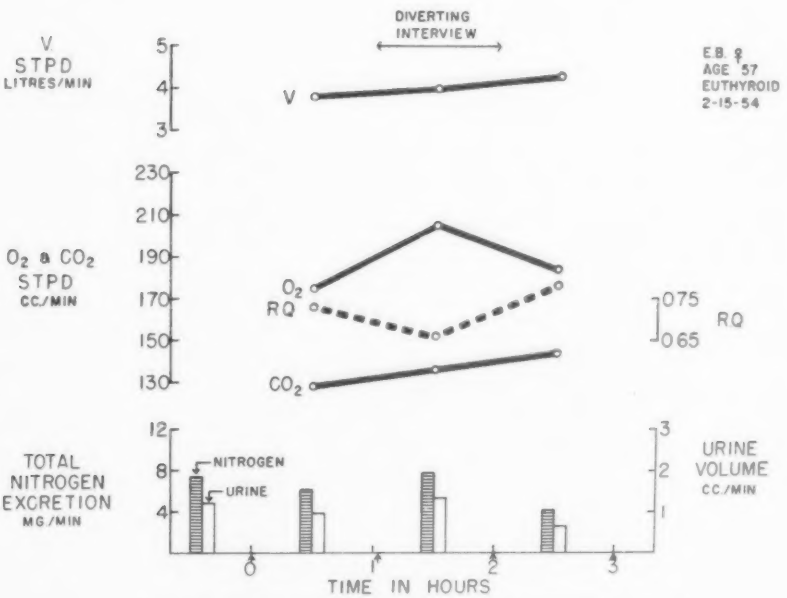

FIG. 4. Smaller metabolic changes during a diverting interview in the subject represented in Fig. 3.

elimination 154 cc/min, RQ 0·78, nitrogen excretion 4·7 mg/min, and urine flow 0·89 cc/min. During the stressful interview she vividly recalled the events associated with the death of her only son five years before. He had been a Navy pilot and was killed in a crash. She described her foreboding about it some hours before the news came, when he did not arrive home on leave on schedule. She had been to his grave one or two times per week for the previous five years. During this interview her oxygen consumption was found to be 238 cc/min, carbon dioxide elimination 142 cc/min, and RQ 0·60; her nitrogen excretion over this period was 8·5 mg/min and urine flow 2·08 cc/min. After this interview, her attention was readily diverted by reading light magazines. Her oxygen consumption an hour later was found to be 195 cc/min, carbon dioxide output 140 cc/min (similar to the values in the first period), urine flow 0·61 cc/min, and nitrogen excretion 3·4 mg/min. A series of observations was carried out on another occasion, during which an attempt was made to divert the patient from stressful topics. This was only partially successful, but smaller variations in gaseous exchange and nitrogen excretion were observed (Fig. 4). The initial levels of oxygen consumption and nitrogen excretion were higher on this occasion, but the patient was not in a completely tranquil state on arrival at the laboratory.

Subject 3. I. G. (Figs. 5 and 6). Even more marked changes were observed in this 40-year-old male with essential hypertension. During the first period, some apprehension in relation to the laboratory procedure itself was noted; his oxygen consumption was 183 cc/min, carbon dioxide elimination 176 cc/min, RQ 0·96, and nitrogen excretion 12·5 mg/min (it was only 8 mg/min prior to arrival at the laboratory). During the second period the painful circumstances surrounding the death of his brother five years before were discussed with him. He had been greatly attached to this brother, and still felt that he had not done enough for him. A rapidly fatal, obscure illness had left him "numb with concern and horror" at what was happening. During this period, his oxygen consumption was found to be 280 cc/min, carbon dioxide output 231 cc/min, RQ 0·82, and nitrogen excretion 14·2 mg/min. After this he was told that he had done all that could reasonably have been expected of him. He accepted this very well and looked considerably relieved. Determination of his gaseous exchange an hour later showed his oxygen consumption to be 235 cc/min, carbon dioxide elimination 210 cc/min, RQ 0·93, and nitrogen excretion 9·5 mg/min. A series of observations was made on another occasion (Fig. 6), when no reference was made to his brother's death. However, it was not possible to keep the patient in a completely tranquil state in the laboratory situation. In the first period his urine flow rose to 2·0 cc/min from an initial level of 0·78 cc/min. His total nitrogen excretion rose from 10·3 to 16·0 mg/min. During the middle period his attention was diverted from the laboratory situation by discussion of his job as a welfare worker and his satisfactory housing situation. The patient appeared more relaxed, but just before the gaseous collection was made he asked a question indicating apprehension about his health. His nitrogen excretion for this period had fallen to 11·0 mg/min and urine flow to 1·7 cc/min, but his oxygen consumption had risen from 210 cc to 249 cc/min (at the end), with only slight change in carbon dioxide elimination, and hence a fall in RQ. In the third period the patient was not kept diverted, and his nitrogen excretion rose again to 13·7 mg/min, with urine flow of 1·81 cc/min; but his oxygen consumption returned to the initial level, with a rise in RQ.

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Comment. These changes in gaseous exchange were smaller than when the stressful interview was given, and the nitrogen excretion fell, in contrast to the rise observed with the stressful interview. This is the only study in which there was lack of correlation between increased nitrogen excretion and increased oxygen consumption with a fall in RQ. The reason may have been that, over the whole hour of the middle period, the patient was more tranquil, but he was not tranquil during the three minutes at the end of the period when the gaseous collection was made.

Separate statistical analysis of the results of the paired experiments on subjects M. P., B. S., E. B., and I. G. by the use of the *t* test, shows the increase in oxygen consumption to be significant at the 6% level, the fall in nonprotein RQ (Table 2) to be significant at the 5% level, and the increase in nitrogen excretion to be significant at the 2% level.

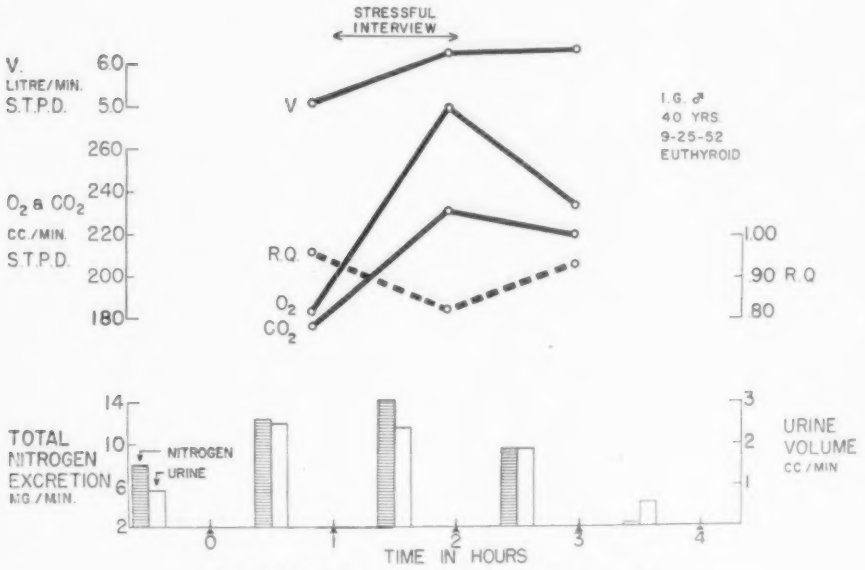

FIG. 5. Metabolic changes associated with a stressful interview in a euthyroid subject

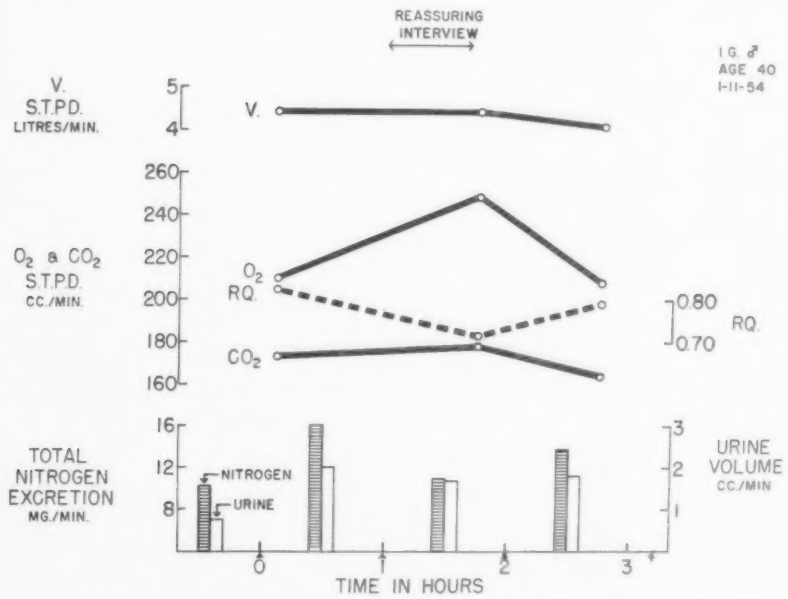

FIG. 6. Smaller metabolic changes during a reassuring interview in the subject represented in Fig. 5.

B. Reactions Without Diuresis

A different pattern of alterations in gaseous exchange and only slight alterations in urine flow and nitrogen excretion (Table 4) were observed in other subjects who manifested feelings of tension, indecision, and resentment in response to the interview.

An example is subject M. L. (Fig. 7), a 32-year-old single woman of Italian extraction, with essential hypertension. She showed parallel increases in oxygen consumption and carbon dioxide

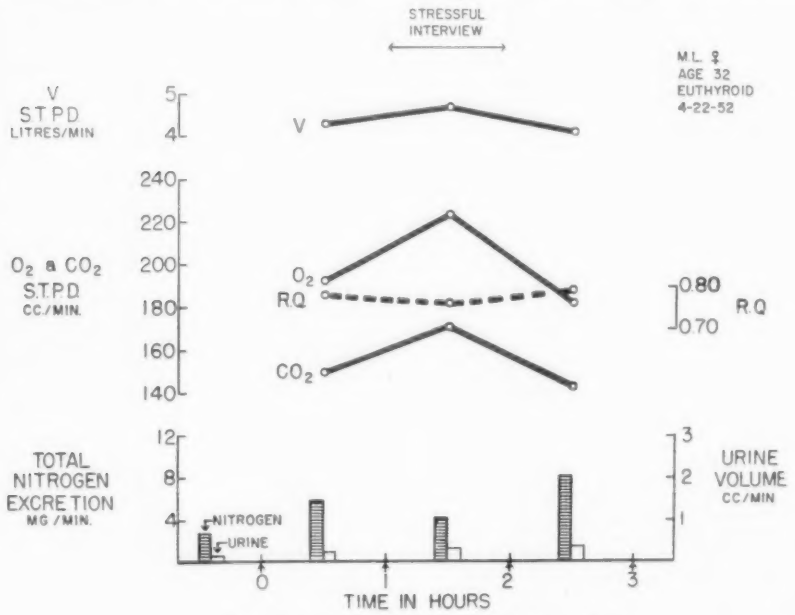

FIG. 7. Metabolism during a stressful interview—reaction without diuresis.

elimination with a slight increase in ventilation during an interview concerned with her relationship to her family, who had prevented her from leaving home to get a job and get married. She described how she was constantly torn between her feelings of loyalty and affection and her resentment at their demands. Her oxygen consumption was 31 cc higher, and the carbon dioxide elimination 21 cc higher, during this period; the RQ remained constant, and there were only slight changes in urine volume and nitrogen excretion. A similar pattern of changes was observed in subjects A. O. and F. L.

3. Observations during Stressful Interviews—Hypothyroid Subjects

In order to make an evaluation of the role of the thyroid in these changes, studies were carried out under similar conditions on hypothyroid subjects maintained on desiccated thyroid. The results are summarized in Table 5.

Subject 1. M. B. had a history of hypothyroidism and had been taking thyroid from infancy. At the time of the experiment she was being maintained in a euthyroid state by 90 mg of desiccated thyroid daily, and her blood cholesterol level was 207 mg per 100 cc. During the initial period she was not tranquil because of apprehension due to the laboratory situation. During this time there was noted (Fig. 8) an increase in her urine flow to 2·9 cc/min (0·7 cc before arrival) and a rise in nitrogen excretion to 7·0 mg/min (4·7 mg before arrival). Her oxygen consumption at this time was

177 cc/min, carbon dioxide elimination 133 cc/min, RQ 0·75, and ventilation 4·8 litres/min. Her fears increased rapidly following an explanation of cardiac catheterization and mention of the possibility that she might have to undergo the procedure. During this period her oxygen consumption was 209 cc/min, and carbon dioxide output 177 cc/min, associated with an increase in ventilation to 5·8 litres/min. Her urine flow was 4·5 cc/min (an increase of 1·6 cc/min) but no increase in nitrogen excretion occurred. Following reassurance that catheterization would not be carried out, the patient was greatly relieved. An hour later her oxygen consumption was 170 cc/min, the urine flow had fallen to 1·1 cc/min, and nitrogen excretion had decreased to 5·3 mg/min. On a subsequent occasion (4 December 1952), during which the patient remained relatively tranquil over a three-hour period, little change in urine volume and nitrogen excretion occurred (Table 5).

TABLE 5.—GENERAL METABOLISM IN HYPOTHYROID SUBJECTS ON DESICCATED THYROID

Subjects					Gaseous exchange STPD					Total nitrogen excretion					
No.	Name	Age	Sex	S.A.		First period	Second period	Third period	Δ		0	1	2	3	Δ
A. Under conditions of relative tranquillity															
1	H. C.	21	F	1·48	O_2	179	190	174	+11	N	4·3	7·1	6·9	6·8	−0·2
					CO_2	150	147	158	−3	F	0·22	0·36	0·36	0·43	0·0
					RQ	0·84	0·77	0·90	−0·07						
					V	4·4	4·4	5·0	0·0						
2	M. B.	28	F	1·55						N	2·2	3·4	3·8	2·2	+0·4
										F	0·40	0·51	0·64	0·40	+0·13
B. During stressful life experiences: reactions associated with diuresis															
1	M. B.	28	F	1·55	O_2	177	209	170	+32	N	4·7	7·0	7·0	5·3	0·0
					CO_2	133	177	128	+44	F	0·70	2·9	4·5	1·1	+1·6
					RQ	0·75	0·85	0·75	+0·10						
					V	4·8	5·8	4·6	+1·0						
2	H. P.	53	F	1·82	O_2	209	247	223	+38	N	4·5	5·8	6·5	6·1	0·7
					CO_2	160	187	170	+27	F	0·67	1·13	2·41	2·26	+1·28
					EQ	0·77	0·76	0·76	−0·01						
					V	4·1	5·1	4·3	+1·0						

Δ Difference between first and second periods (columns 1 and 2).
O_2 Oxygen consumption in cc/min.
CO_2 Carbon dioxide elimination in cc/min.
V Ventilation in litres/min.
STPD Standard temperature and pressure, dry.
N Total nitrogen in mg/min.
F Urine flow in cc/min.
Diuresis—Urine flow in excess of 1 cc/min in second period.

Subject 2. In H. P. a similar pattern of changes was observed (Fig. 9). In this 53-year-old woman hypothyroidism had developed following subtotal thyroidectomy for chronic thyroiditis (struma lymphomatosa) fourteen years previously. At the time of the study she was taking 120 mg of thyroid daily, but she was not yet clinically euthyroid. Her serum cholesterol level was 218 mg per 100 cc. A stimulus, similar to that in the case of M. B., was used. The patient reacted in a similar fashion, with considerable apprehension. There was marked diuresis with an increase in urine flow to 2·4 cc/min (from 1·1 cc/min in the first period), but nitrogen excretion rose by only 0·7 mg/min (from 5·8 to 6·5 mg). An increase in oxygen consumption of +38 cc/min, associated with an increase in carbon dioxide elimination of 27 cc/min and an increase in ventilation of 0·95 litre/min was observed.

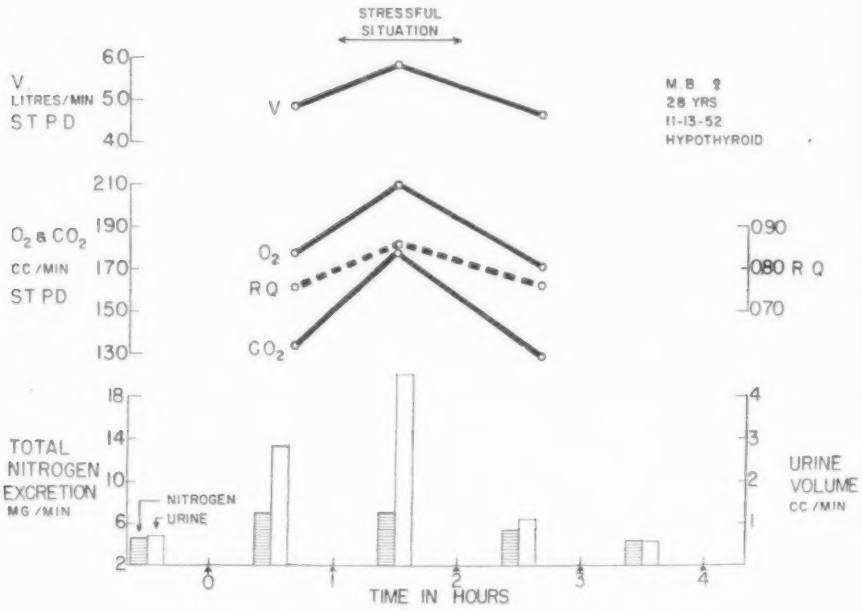

FIG. 8. Metabolism during a stressful situation in a hypothyroid subject treated with desiccated thyroid.

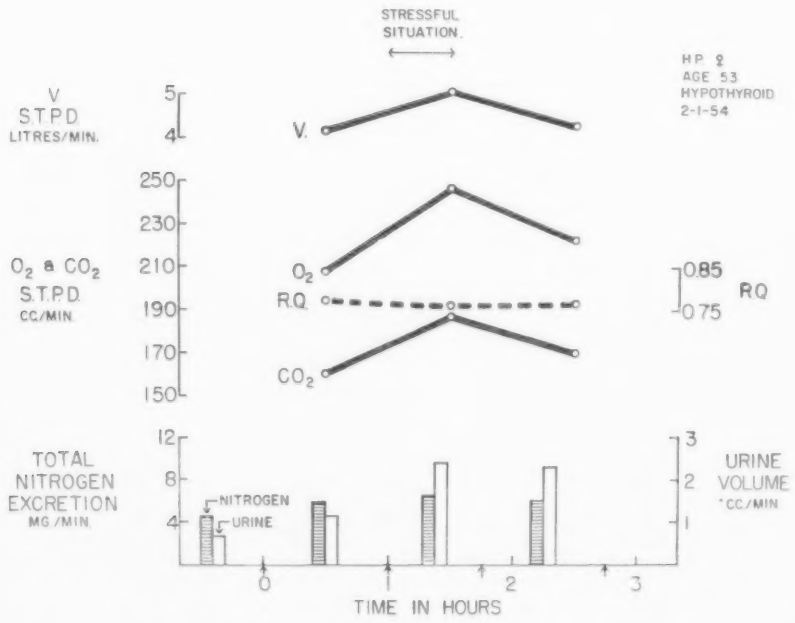

FIG. 9. Metabolism during a stressful situation in a hypothyroid subject treated with desiccated thyroid.

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In the third period the patient was not completely reassured, and nitrogen excretion and urine flow subsided only slightly. However, ventilation and gaseous exchange regressed toward their initial level.

These two studies suggest that under similar conditions, in situations provoking diuresis and feelings of dread and apprehension, hypothyroid subjects do not show the changes in oxygen consumption, RQ, and nitrogen excretion generally observed in euthyroid subjects.

4. *Observations during Stressful Interviews in Adrenalectomized Subjects*

In order to evaluate the role of the adrenal medulla and cortex in these changes, observations were made on two totally adrenalectomized subjects maintained on cortisone (25 mg daily), and desoxycorticosterone acetate. The results are summarized in Table 6.

TABLE 6.—GENERAL METABOLISM DURING STRESSFUL INTERVIEWS IN 2 ADRENALECTOMIZED SUBJECTS MAINTAINED ON CORTISONE AND D.C.A.

Subjects					Gaseous exchange STPD					Total N excretion and urine flow					
No.	Name	Age	Sex	S.A.		First period	Second period	Third period	Δ		0	1	2	3	Δ
1	R. H.	40	F	1·70	O_2	220	240	225	+20	N	7·1	11·3	11·0	10·0	−0·3
					CO_2	182	176	188	−6	F	0·47	0·78	0·71	0·63	−0·07
					RQ	0·83	0·73	0·836	−0·10						
					V	5·7	5·9	5·8	+0·2						
2	R. L.	34	F	1·50	O_2	169	183	157	+14	N	10·3	6·7	7·9	6·6	+1·2
					CO_2	136	139	141	+3	F	0·44	0·38	0·48	0·37	+0·10
					RQ	0·81	0·76	0·90	−0·05						
					V	4·3	4·0	4·7	−0·3						

Δ Difference between first and second periods (columns 1 and 2).
O_2 Oxygen consumption in cc/min.
CO_2 Carbon dioxide elimination in cc/min.
V Ventilation in litres/min.
STPD Standard temperature and pressure, dry.
N Total nitrogen in mg/min.
F Urine flow in cc/min.

Both these patients had been subjected to total adrenalectomy for adrenal cortical hyperplasia manifesting itself as Cushing's syndrome with hypertension. Removal was complete five months before in the case of R. H., and nine months before in the case of R. L.

As in the other studies, during the middle period (Table 6) topics known to be sources of anxiety such as their health were discussed with them. In neither case did an increase in urine flow to a level in excess of 1 cc/min occur. However, in R. H. there was a significant increase in oxygen consumption from 220 to 240 cc/min, with a fall in RQ from 0·83 to 0·73, while the total nitrogen excretion had previously risen from 7·1 to 11·3 mg/min. Smaller changes occurred in R. L.

These findings suggest that neither the adrenal medulla or cortex is necessary for the occurrence of the changes observed in the euthyroid subjects.

DISCUSSION

The data show that during reactions associated with diuresis and feelings of dread and apprehension there is a significant rise in oxygen consumption and a fall in nonprotein RQ. This pattern suggests increased fat catabolism. In association with these changes there are significant increases in urinary nitrogen excretion. These alterations are not associated with a fall in the nonprotein nitrogen level of the blood, but they are associated with an increase in potassium excretion (HETZEL *et al.*, 1956) and are not simply dependent on increased urine flow. From their evidence it appears reasonable to conclude that the increase in nitrogen excretion reflects increased protein catabolism. The data, therefore, suggest that the metabolic pattern characteristic of the response to surgical trauma (CUTHBERTSON, 1942; MOORE, 1950) may also be elicited in response to threats in the form of stressful life situations. It is of interest that elevated levels of blood ketones in association with stressful life situations have been reported previously by HINKLE *et al.* (1950).

No definitive statement can be made about the significance of the increases in oxygen consumption and carbon dioxide elimination with rise in RQ, associated with a variable increase in ventilation, that were observed in euthyroid subjects not showing a diuresis. Whether these changes resulted primarily from increased carbon dioxide production or simply from increased ventilation cannot be stated without measurements of blood carbon dioxide content. It is possible, however, that this pattern of changes is indicative of carbohydrate utilization, rather than the protein and fat catabolism already discussed. Such a pattern has been observed following administration of epinephrine (GRIFFITH, 1951), which could be the mediator under the conditions of these experiments, though a rise in blood sugar has not been observed.

It was of interest that those subjects not showing a diuresis reacted with feelings of frustration, depression, or resentment in contrast to the dread and apprehension seen in those showing an increase in urine flow. Changes in metabolic rate during different emotions have been previously investigated by ZIEGLER and LEVINE (1925), using the Tissot-Haldane method with a similar experimental design. These observers found that an increase in metabolic rate occurred in association with "excitement," but that when depression or resentment were present, no increase occurred.

Evidence for the role of the thyroid in these catabolic changes associated with diuresis comes from the observations in hypothyroid subjects under the same conditions. Increases in oxygen consumption without a fall in RQ were observed in two cases showing diuresis, while the changes in nitrogen and potassium excretion were significantly less (HETZEL *et al.*, 1956). The possible mechanism of participation by the thyroid in such a rapid metabolic adjustment is of considerable interest. This question is discussed subsequently (HETZEL *et al.*, 1956), but it appears possible that tri-iodothyronine or some similar rapidly effective thyroid agent may be involved. However, fat mobilization in animals or fall of RQ in man has not been observed following the administration of thryoxine (BOOTHBY *et al.*, 1925; PAYNE, 1949). The possibility of the pituitary being directly involved is suggested by animal studies. PAYNE (1949) and ROSENBERG (1953), have presented data on rapid adipokinetic effects of a fraction of anterior pituitary extract occurring independently of the thyroid. Nitrogen excretion was not measured in these experiments.

The role of the adrenal cortex in these changes has been evaluated by concurrent

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determination of 17-hydroxycorticosteroid excretion in the urine. These urinary corticoids are usually increased in association with the increase in nitrogen excretion in euthyroid subjects, and similar increases have been observed in hypothyroid subjects (HETZEL *et al.*, 1955). The data from the adrenalectomized subject R. H. suggests that neither the adrenal cortex or medulla exerts a primary causative role in these changes, a concept which is also supported by data from animal experiments (ENGEL, 1952).

It is apparent that the data available so far do not permit any definite conclusion as to the mechanism underlying these changes—presumably autonomic discharge may also be involved. However, the findings are of immediate clinical interest in relation to diseases where changes in the rate of catabolism are of great importance. For example, patients with chronic renal insufficiency, diabetes mellitus, or endocrine disorders may deteriorate not only as a result of the catabolism of infection but also from that associated with certain types of emotional disturbance.

SUMMARY

(1) Determinations of gaseous exchange and total nitrogen excretion have been carried out before, during, and after acute stressful interviews in the laboratory, in euthyroid, hypothyroid, and adrenalectomized subjects.

(2) Under conditions of relative tranquillity, only small fluctuations were observed.

(3) In association with reactions to stressful interviews accompanied by diuresis and feelings of dread or apprehension, increases in oxygen consumption with a fall in nonprotein RQ and increased nitrogen excretion were observed in euthyroid subjects. Reactions not accompanied by diuresis and involving other emotions (predominantly resentment and depression) were not associated with these changes.

(4) In two hypothyroid subjects on thyroid, reactions to stressful interviews accompanied by diuresis have not been accompanied by similar changes to those observed in euthyroid subjects, while in one adrenalectomized subject on maintenance therapy these changes were observed.

(5) The significance of these findings is discussed, but no final conclusion as to the mechanisms involved is drawn.

Acknowledgement—The authors wish to thank Dr. DANIEL S. LUKAS of the New York Hospital staff for his help in carrying out the determinations of gaseous exchange. and Drs. E. SHORR, E. COHEN, and J. E. BALL for co-operation and encouragement.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 203 to 211. Pergamon Press Ltd., London

LIFE SITUATIONS, BEHAVIOUR, ATTITUDES, EMOTIONS, AND RENAL EXCRETION OF FLUID AND ELECTROLYTES*—III†

DIURESIS OF FLUID AND ELECTROLYTES

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IN a report on diuresis occurring during stressful life situations, HINKLE, EDWARDS, and WOLF (1951) demonstrated a considerable increase in urine volume during periods of "anxiety." They pointed out that this association of anxiety and diuresis had long been known, but had not been subjected to careful study. The present studies were undertaken to elucidate more clearly the relationship existing between life situations, emotions, attitudes, and behaviour on the one hand and renal excretion of fluid and electrolyte on the other. Details of the method used in these experiments have been presented (SCHOTTSTAEDT, GRACE, and WOLFF, 1956a) as has the method of evaluating feeling states (SCHOTTSTAEDT, GRACE, and WOLFF, 1956b). Rates of renal excretion of water, sodium, and potassium have been reported (SCHOTTSTAEDT, *et al.*, 1956b) during periods considered neutral and tranquil, and accompanying situations eliciting reaction patterns *A* and *A'* in the five subjects studied for two to six weeks. This communication will present data on life situations and behaviour patterns associated in these same subjects with increased excretion of water and sodium, and often of potassium as well. It will also present data obtained in laboratory experiments under fasting conditions wherein similar reaction patterns were evoked in other subjects.

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RESULTS

A. *Long-term Observations*

Situations which seemed "challenging" to these individuals evoked two emotional responses which appeared to be differentiated by whether the experience was pleasant or unpleasant. Thus the subject might describe his reaction as "excitement" or "stimulation" in meeting the challenge of new ideas or mastering a situation previously difficult to handle. On the other hand, the subject might react to similar situations with feelings of apprehension, anxiety, or uneasiness. Situations eliciting clearly definable reactions of this type have been grouped together as pattern *B*. Rates of renal excretion of water, sodium, and potassium observed in association with this reaction pattern are presented in Table 1.

Subject #1 was devoted to friends and relatives, and enjoyed being with them whenever she could. During the period of observation, a cousin, of whom she was very fond, was married. The subject entered into wedding arrangements with considerable vigour. Special flowers were being shipped by air, and she agreed to pick these up at the airport on the morning of the wedding. This necessitated a trip to La Guardia airfield, locating the air express depot, getting the flowers, and returning in time to have them cut and arranged before the afternoon ceremony. The time allotted seemed grossly inadequate to her, and she was fearful that the shipment would be late or traffic would delay her. In

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† Part III represents the third of a series of five papers which are being published consecutively.

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TABLE 1.—RENAL EXCRETION OF WATER, SODIUM AND POTASSIUM IN ASSOCIATION WITH PATTERN *B*

Subject	Time	Situation	5-hour excretion			5-hour intake		
			H_2O (cc/min)	Na (μeq/min)	K (μeq/min)	H_2O (cc)	Na (meq)	K (meq)
#1	a.m.	Flowers for wedding (see text)	2·21	140	50	0	0	0
	aft.	Received "exciting" mail	1·18	179	98	450	33	18
	evg.	Meeting husband's relatives first	1·81	151	47	675	17	10
		Shower for bride	1·25	232	57	750	66	45
		Newlyweds for dinner	1·73	190	91	1000	109	83
		Dinner in Manhattan	1·44	145	25	840	112	35
		Working crossword puzzle	1·18	167	73	300	90	42
	night	Sleeping after dinner for newlyweds	1·31	192	34	250	0	0
		Sleeping after stimulating evening	1·56	176	34	0	0	0
		Sleeping before trip for flowers (see text)	1·86	171	45	0	0	0
#2	a.m.	Stimulating morning with patients	1·70	281	71	510	25	14
	evg.	Apprehensive on trip to see patient	1·61	184	54	850	22	26
		Stimulating evening out	1·39	229	118	400	35	31
	night	Awakened during night with new ideas about work	1·68	170	31	0	0	0
		Restless sleep	2·65	163	56	0	0	0
#3	a.m.	Boy friend gone; "will never return"	3·13	154	59	Data incomplete		
		Everything straightened out with boy friend	2·16	200	42			
	evg.	Stimulating evening	2·03	213	67			
		Boy friend's sister made disturbing accusations	2·43	102	31			
#4	a.m.	Stimulating morning	1·30	312	77	200	29	6
		Apprehensive about illness and duties	1·74	337	107	300	18	12
	aft.	Afternoon drive in new car	1·26	290	102	600	102	25
	evg.	Stimulated by reading	1·17	364	72	400	20	21
#5	a.m.	Stimulated by work	1·35	336	72	630	84	25
		Stimulated by experimental results	1·46	310	28	240	0	0
	aft.	Stimulated by work	1·85	445	110	480	133	23
	night	Worried about wife's illness	1·57	358	86	360	36	9
		Sleeping after "exciting" movie	1·57	370	55	470	20	10
		Decision not made; deadline approaching	1·79	425	34	780	0	0
		Stimulated by evening discussion	1·67	371	48	690	17	14

either event, she feared they would not be arranged in time. She described her feeling state during this time as one of uneasiness or apprehension, since she was not sure she could carry out her duties and have enough time for making the proper floral arrangements. Excretion rates during this period of observation are given in Table 1. Comparative data for neutral and tranquil periods are presented in Table 5.

This same subject had entered married life feeling considerable doubts as to her ability to prepare and serve dinner properly to guests. She quickly found she could manage very well, and felt excited and pleased when "company dinners" were handled successfully. On such occasions she felt excited by successful mastery of a previously threatening situation. Whether the subject reacted with apprehension or excitement, these situations were associated with higher rates of excretion of water and sodium than were observed during neutral and tranquil periods (Table 5).

Subject #2 was a medical resident who, in the course of his clinic work, was often treating patients with difficult psychiatric problems. On mornings when he interviewed these patients he felt alert, stimulated, and challenged. Subjects #4 and #5 were also medical residents. They were engaged in research of absorbing interest to them. While working on their data, they frequently felt stimulated and excited.

Subject #3 was a research worker for an encyclopaedia. Her relationships with others were quite

tempestuous. One day the boy with whom she had been "going" got angry, quarrelled with her, and left town. For some time after this she tried to think of ways of patching up their differences and getting him to return. During this period her predominant feelings were of apprehension lest he might not return.

Thirty situations were recorded which these subjects felt had clearly evoked this reaction pattern. These situations had in common the feature of challenging the individual in such a way that he reacted either with pleasurable feelings of excitement and stimulation or with unpleasant feelings of apprehension or uneasiness. These situations and reactions were associated with a uniform increase in excretion rates of water and sodium, but with a variable response in excretion rates for potassium.

Situations did not always evoke emotional reactions which could be clearly categorized in pattern *B*, even though feelings of pleasant stimulation or of apprehension were present. Thus, on occasion, the subjects felt that elements of pattern *A* were present simultaneously with pattern *B*, and could not state with certainty that either reaction was predominant. At such times they were apt to describe their feeling state as "tense and excited," "tense and anxious," or "stimulated, but working tensely." An example of this combination of reaction patterns was seen in Subject #3, a single, young woman who lived alone in an apartment. One evening her boy friend fell asleep in her apartment and slept there all night. Since she knew her neighbours had more than a passing interest in her activities and kept close account of when her guests arrived and left, she reacted to this episode with both "tension" and "apprehension."

There were eighteen situations which the subjects of these experiments felt were combinations of patterns *A* and *B* (Table 2). Associated with these situations, there

TABLE 2.—RENAL EXCRETION OF WATER, SODIUM, AND POTASSIUM IN ASSOCIATION WITH PATTERNS *A* AND *B* COMBINED

Subject	Time	Situation	5-hour excretion			5-hour intake		
			H_2O (cc/min)	Na (μeq/min)	K (μeq/min)	H_2O (cc)	Na (meq)	K (meq)
#1	aft.	Guest arrived; plans had to be changed	0·75	125	55	350	28	9
	evg.	Writing letter about accepting a job	0·85	228	41	750	135	48
#2	evg.	Stimulating, concentrated work	0·83	213	66	1570	66	34
#3	a.m.	Wondering why friend "cool" toward her	1·17	192	69	Data incomplete		
	evg.	Uncomfortable visit with friend	1·12	154	17			
	night	Boy friend spent night in her room	0·87	136	49			
#4	evg.	Stimulating, concentrated work	0·98	283	113	490	54	33
		Stimulating, concentrated work	0·81	176	88	680	68	48
	night	Restless night after tense day; stimulating thought	1·01	182	57	0	0	0
		Stimulating evening; awoke "tense"	1·03	176	40	0	0	0
#5	aft.	Intensive but stimulating work	1·21	230	119	590	34	25
		"Tense and excited" at work	1·15	240	42	450	51	11
		Stimulating work	1·24	225	56	590	98	25
		"Tense and anxious" about work	1·15	273	49	520	85	10
	evg.	Intensive but stimulating work	1·18	237	71	1040	244	54
		Attended "exciting" movie	1·15	249	61	480	97	31
		"Tense and excited" over experimental data	1·22	215	130	420	95	29
	night	Stimulated by evening work; awakened "tense"	0·68	149	29	180	14	5

was an increase in rates of excretion of both sodium and water over rates observed in association with pattern *A* alone (Table 5). This increase brought urine volumes into the range observed during neutral periods. Sodium excretion was in excess of that observed during neutral periods in four of the five subjects. In association with combinations of patterns *A* and *B*, Subject #5 had rates of both water and sodium excretion which were in the range of those observed during meutral and tranquil periods.

Situations evoking patterns of aggressive behaviour and feelings of anger were associated with increases in excretion rates of water and sodium similar to those accompanying pattern *B*. This pattern of behaviour, emotions, and excretion rates will be referred to as pattern *B′*. Table 3 summarizes the data obtained during twenty-two situations observed which evoked this pattern.

Subject #1 was a quiet orderly individual who felt that any overt display of anger was indefensible. She was deeply interested in the work her husband was doing, and determined never to let her demands interfere with his professional interests. At the same time, she resented any interference with their Sundays together. The activities of one such week-end she had planned for several weeks in advance, looking forward to this as a respite from child-care and household duties. Her husband, however, became absorbed in his work a few days before this and forgot these plans completely. Sunday found him working at his desk, his only request being that she keep the children quiet. She reacted violently, inwardly, to this disregard of her plans and desires. But, true to her determination not to let her demands interfere with his work, she "swallowed" her anger and took the children off to a playground. She did not express this anger in her behaviour, though she continued to feel angry throughout the

TABLE 3.—RENAL EXCRETION OF WATER, SODIUM, AND POTASSIUM IN ASSOCIATION WITH PATTERN *B′*

Subject	Time	Situation	5-hour excretion			5-hour intake		
			H_2O (cc/min)	Na (μeq/min)	K (μeq/min)	H_2O (cc)	Na (meq)	K (meq)
#1	a.m.	Angry at self for inactivity	1·63	211	71	300	67	7
	aft.	Angry at husband for forgetting plans	1·76	422	118	600	56	19
		Constant irritations from children	2·62	214	127	450	76	54
	evg.	Children source of anger	1·01	212	66	800	29	31
#2	a.m.	Ready to fire technician	1·11	198	60	400	20	7
	aft.	Irritable with children	1·13	146	87	1280	45	38
#3	a.m.	Poem rejected by publishers	1·67	147	55	Data incomplete		
		Fight with friend	2·60	147	34			
		Humiliated by boss	2·88	289	153			
		Ignored by boss	1·86	165	65			
		Colleague gave her "a dirty look"	2·50	276	64			
		Infuriated by colleague's rejection of her	2·59	332	52			
	aft.	Angry; refused to see boy friend	2·49	218	41			
		Guilty at her treatment of boy friend	2·67	156	31			
		Angry at behaviour of boy friend	3·86	167	56			
		Brooding over rejection by colleague	3·20	168	52			
		Still brooding over rejection	2·14	149	48			
	evg.	Fight with friend	1·47	194	35			
#4	evg.	Smouldering irritation at change in plans	1·38	387	101	490	81	28
#5	a.m.	Expressed anger at secretary	1·97	537	144	600	109	15
	aft.	Angry at secretary	1·85	445	110	480	133	24
	night	Awakened twice feeling angry at secretary	2·33	525	38	0	0	0

afternoon. Renal excretion rates during this observation period were markedly increased. 126 meq of sodium (nearly 8 g of salt) were excreted during the five-hour period of observation. This is only 10 meq less than her total daily intake.

Subject #2 also found it difficult to express anger. He was orderly in his personal habits and liked those about him to be equally so. One technician who worked for him was conspicuously lacking in this trait. His work was repeatedly in question and often had to be checked by others. This infuriated the subject, who yet found it impossible to express this anger in any effective fashion. Finally, after a gross blunder by this technician, he decided he would have to be dismissed. During the period of anger in which he was contemplating dismissal of the technician, excretion rates of water and sodium were increased.

Subject #3 had been referred to us because of outbursts of "uncontrollable rage." She was easily angered, and her feelings of anger were ordinarily expressed physically by hitting or kicking the offending individual. On one occasion she broke down a door and used the broken pieces to beat her "boy friend," who had offended her by failing to meet her when he had promised. Two of her colleagues at work visited her one evening in her apartment. They became engaged in a long discussion of the philosophy expressed in mediaeval art. She knew nothing about mediaeval art and cared less. She asked them to talk about something more interesting. When they persisted in their discussion, she threw them out of the apartment bodily and ran down the stairs after them, kicking them out the door to express her displeasure. When one of them gave her what she considered to be a few "dirty looks" the next day at work, she was furious. She asked him to have lunch with her to find out if he really meant what she thought he meant. When he refused to have lunch with her, she became enraged. During these episodes, renal excretion rates of water and sodium were increased.

Potassium excretion was markedly elevated on but a single occasion in Subject #3. She became intensely angry at her supervisor one day for a remark which she considered humiliating. Because she had been threatened with dismissal from her job if she had any further outbursts of temper, she felt constrained to control her anger. Potassium excretion during this period was 153 μeq/min. On no other occasion did potassium excretion exceed 70 μeq/min in this subject.

Subject #5 was a physician "raised" as a Canadian lumberman. A powerful physique had enabled him partially to support himself through medical training as a professional athlete. He had a flair for the dramatic and a temper which, though slowly aroused, could be of considerable proportions. He had been given a secretary to help in his work. He did not care for her nor she for him. Consequently, she conveniently "forgot" to do whatever she felt was not strictly her duty. After repeated requests that she perform some minor tasks, he arrived one Saturday morning to find them still undone, though the deadline had arrived. He did them himself, but spent the weekend preparing a speech to deliver to her when she returned on Monday morning. Monday morning came, but she was late to work. He seethed inwardly, becoming increasingly angry as the hour grew later. When she finally arrived at 1100, he unleashed his fury so completely that he feared he was going to lose control of himself. He felt a desire to choke her. During this period of intense anger, expression of which was controlled with difficulty, his renal excretion rates were 4·67 cc/min for water, 1101 μeq/min for sodium, 256 μeq/min for potassium. This collection period was for 75 min. When pooled for 5 h to make it comparable to other figures given in this paper, renal excretion rates were 1·97 cc/min for water, 537 μeq/min for sodium, and 144 μeq/min for potassium (Table 3).

In these five subjects, situations associated with feelings of anger were accompanied uniformly by an increased excretion of water and sodium. The increase in urine volume averaged 114%; the increase in sodium excretion averaged 156%. Though potassium excretion varied markedly, the majority of excretion rates were elevated. In these subjects the increase in potassium excretion averaged 58%.

As with pattern *B*, pattern *B'* was sometimes observed in association with pattern *A*. Situations sometimes aroused feelings of alert readiness for response, of tension, and of anger simultaneously. Aggressive behaviour might be expressed only as working with unusual vigour accompanied by feelings of "pushing" or being "under pressure." This latter feeling might be associated with an awareness of feelings of anger, but often was not. The five subjects studied, categorized thirty-six situations and

TABLE 4.—RENAL EXCRETION OF WATER, SODIUM, AND POTASSIUM IN ASSOCIATION WITH PATTERNS *A* AND *B′* COMBINED

Subject	Time	Situation	5-hour excretion			5-hour intake		
			H_2O (cc/min)	Na (μeq/min)	K (μeq/min)	H_2O (cc)	Na (meq)	K (meq)
#1	aft.	Trying to put more into a full routine	0·83	183	42	150	35	4
	evg.	Six children and many extra duties	0·65	140	32	450	91	35
		Husband very late for dinner	0·61	161	62	750	75	49
		Dinner guests. Additional guests in evening	0·70	143	50	800	38	33
	night	Under pressure of many unfinished jobs	0·76	115	18	300	0	0
		Uncomfortable night on cot	0·99	171	42	0	0	0
#2	a.m.	Doing experimental procedure on friends	0·90	140	13	440	30	15
		Hostile patient	0·82	179	73	400	20	7
		Working on experimental data	0·92	184	67	500	13	12
		Hostile and demanding patient	0·97	205	55	700	26	12
		Several patients requiring careful handling	0·89	167	58	640	30	15
		Attacked verbally by disturbed patient	0·97	167	67	600	22	18
		Superior dissatisfied with work	0·89	196	79	600	21	10
	aft.	Full afternoon; turned patients away	0·78	147	63	640	67	30
		Fired technician	0·73	157	56	420	57	30
	evg.	Intensive work; irritated by colleague	0·84	140	54	920	65	30
#3	a.m.	Colleague "cool" toward her	1·17	192	69	Data incomplete		
#4	a.m.	Feeling "frustrated" by work	0·89	175	91	200	40	8
		Many irritations during morning	0·88	236	75	200	29	6
		Working under pressure	0·68	142	82	200	24	7
	aft.	Forcing self to work	0·84	155	107	220	35	6
		Under pressure to get application completed	0·84	249	46	500	96	28
		Tending children and trying to read	1·05	188	118	870	65	17
		Too many things to do	0·71	121	84	810	60	26
		"Tense and irritable" at work	0·66	144	106	290	63	23
	evg.	"Tense and irritable" at home	0·72	322	118	550	45	24
		Forcing self to work; "tense"	0·46	165	63	540	35	32
		"Pushing" to get things done	0·82	197	71	200	27	11
		Tense and irritable after full day	0·68	139	91	540	59	32
		Tense and irritable after full day	0·63	154	52	290	65	23
	night	Restless after irritating evening	0·94	178	76	0	0	0
		Restless after irritating evening	0·65	160	45	0	0	0
#5	a.m.	Intensive work; angry at secretary	1·11	247	68	800	99	23
		Under pressure to meet deadline	0·73	172	53	780	93	13
		Under pressure to meet deadline	0·85	177	39	840	98	17
	aft.	Under pressure to meet deadline	1·24	289	67	350	75	41

emotional responses as being combinations of patterns *A* and *B′* (Table 4). In association with these situations, rates of renal excretion for water were between those observed for either pattern *A* or *B′* occurring singly, falling approximately in the range observed during neutral periods (Table 5). Renal excretion rates for sodium also fell between those observed for either pattern occurring singly, but generally were elevated well above rates observed during neutral periods.

B. *Short-term Laboratory Observations*

Experiments have been conducted in a laboratory setting in an effort to reproduce these reaction patterns and their associated renal excretion patterns through stress

interviews or stressful situations. For this purpose, all experiments were conducted in the same room and during the morning hours. Subjects were fasting and had taken no

TABLE 5.—COMPARISON OF RENAL EXCRETION IN ASSOCIATION WITH VARIOUS REACTION PATTERNS

Reaction pattern	Subject	Number of observations	Average excretion rate		
			H_2O (cc/min)	Na (μeq/min)	K (daytime only) (μeq/min)
Neutral	1	47	0·76	96	54
	2	32	0·67	97	56
	3	13	0·83	85	37
	4	16	0·69	100	60
	5	11	1·18	246	80
Pattern *A*	1	34	0·54	61	50
	2	11	0·52	68	44
	3	14	0·66	55	23
	4	24	0·46	60	54
	5	11	0·77	143	61
Pattern *B*	1	10	1·55	174	63
	2	5	1·81	205	81
	3	4	2·19	167	50
	4	4	1·37	328	89
	5	7	1·61	374	70
Patterns *A* and *B*	1	2	0·80	177	48
	2	1	0·83	213	66
	3	3	1·05	161	43
	4	4	0·96	204	100
	5	8	1·12	227	75
Pattern *B′*	1	4	1·75	265	96
	2	2	1·12	172	74
	3	12	2·49	201	57
	4	1	1·38	387	101
	5	3	2·05	502	127
Patterns *A* and *B′*	1	6	0·76	152	46
	2	10	0·87	168	59
	3	1	1·17	192	69
	4	15	0·76	182	85
	5	4	0·98	221	57

fluid for at least twelve hours prior to beginning the experiment. Following an hour of quiet sitting to obtain base-line data, these subjects were engaged in a discussion of neutral topics or of topics known to evoke strong emotional reactions. The emotion or feeling state present was evaluated by subject and observer. Results of these experiments are given in Table 6.

TABLE 6.—RENAL EXCRETION UNDER FASTING CONDITIONS IN LABORATORY EXPERIMENTS REPRODUCING VARIOUS REACTION PATTERNS

Reaction pattern	Situation	Renal excretion of		
		H_2O (cc/min)	(Na) (μeq/min)	K (μeq/min)
Neutral	Neutral period before interview	0·93	73	66
	Neutral period before interview	0·56	91	74
	Hour spent quietly reading magazine	0·65	67	47
	Reading sociology text	1·01	68	49
	Non-stressful interview	0·80	102	60
	Sitting quietly; tranquil	0·62	95	59
	Neutral period after interview	0·71	74	64
	Neutral period after interview	0·57	78	53
	Average	0·73	81	59
Pattern *B*	Discussion of sympathectomy with hypertensive	1·87	364	96
	Expression of anxiety and self-pity	2·17	464	98
	Awaiting decision regarding psychiatric hospitalization	1·79	325	165
	Discussion of overt homosexuality	1·05	175	111
	Awaiting dentist	2·46	564	107
	Discussion of feelings toward mother	2·44	263	70
	Discussion of brother's death	2·40	158	85
	Awaiting first BMR (patient with anxiety state)	1·20	182	57
	Average	1·92	311	99
Pattern *B'*	Irritated at work assigned	1·53	280	102
	Stressful interview with patient	1·54	231	124
	Discussion of racial discrimination with negro	2·34	464	51
	Angry at technician for missing vein repeatedly	1·49	217	69
	Average	1·73	298	86
Patterns *A* and *B'*	Under pressure to make decision about moving	0·59	100	48
	Discussion of being "trapped" into marriage	0·82	148	116
	Discussion: fate repeatedly against him	0·66	148	59
	Arrived for test; nothing ready	1·00	224	78
	Angry at colleague for missing vein repeatedly	0·96	256	59
	Average	0·81	175	72

One subject was a 31-year-old woman with severe hypertension and angina. Two years previously she had been advised to have thoracolumbar sympathectomy. The prospect of operation frightened her, however, and she hesitated. She was then told she would die in two years if she did not submit to the surgical treatment, and she was not assured of more than two years of life even though the operation be done. She decided against the operation. During a period when tests were being performed to establish the progress of her disease, she was interviewed again. It was suggested that "surgery" might still be a profitable procedure and she was urged to reconsider her decision. She related her previous discussions on this subject in some detail and with obvious feeling. She was apprehensive during this discussion, and fearful that she might be "talked into surgery" against her "better judgement." Excretion rates accompanying this discussion were 2·17 cc/min for water, 464 μeq/min for sodium, and 98 μeq/min for potassium. Excretion rates during a neutral period spent quietly reading a magazine were 0·65 cc/min for water, 67 μeq/min for sodium, and 47 μeq/min for potassium.

Another subject of these experiments was a woman who had married a man with rheumatic heart

disease. Prior to their marriage no word had been said of any illness, yet shortly after the marriage he became a chronic invalid requiring constant attention. She felt she had been "trapped" into the marriage through "misrepresentation," and yet felt obliged to "see it through." During a discussion of her marriage, its irritations and frustration, and her feelings at not being informed of the illness before marriage, she felt "tense" and "angry." The interviewer agreed in this evaluation. Excretion rates during the discussion were 0·82 cc/min for water, 148 μeq/min for sodium, and 59 μeq/min for potassium, as compared with excretion rates during the base-line period of 0·56 cc/min for water, 91 μeq/min for sodium, and 74 μeq/min for potassium.

Table 6 summarizes these data and demonstrates that, even with abstinence from fluid ingestion for twelve or more hours, situations or interviews evoking the reaction patterns described were accompanied by renal excretion rates for water, sodium, and potassium similar to those observed in the long-term studies reported.

SUMMARY AND CONCLUSIONS

(1) In thirty situations which evoked a clearly definable reaction pattern characterized by feelings of excitement, uneasiness, or apprehension (pattern *B*), renal excretion rates of water and sodium were increased as compared with excretion rates observed in the same subjects during neutral and tranquil periods.

(2) In twenty-two situations which evoked a clearly definable reaction pattern characterized by aggressive behaviour or feelings of "anger" (pattern *B'*), renal excretion rates of water and sodium were also increased as compared with excretion rates observed in the same subjects during neutral and tranquil periods.

(3) Situations evoking mixed reaction patterns combining attitudes and feelings present in patterns *A* and *B'* were accompanied by excretion rates of water and sodium which were usually intermediate between the two patterns. Under these circumstances, renal excretion rates of water were comparable to those observed during neutral periods, while renal excretion rates of sodium were elevated above those observed during neutral periods.

When these reaction patterns were reproduced in a laboratory setting under fasting conditions, renal excretion rates showed comparable changes from rates observed during neutral periods under the same circumstances.

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PSYCHOSOMATIC ASPECTS OF ASTHMA IN ELDERLY PATIENTS

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IN a study of aetiological factors in a group of 441 asthmatics (REES 1956), age and sex factors were found to be very important, and interesting differences in the relative incidence and importance of aetiological factors were found in different age and sex groups. It was therefore decided to make a special study of asthmatics over the age of 60, with a view to determining the relative importance of various aetiological factors, and how asthma was influenced by the changed constitutional status and altered environmental relationships associated with later life. It is often assumed that asthma in elderly patients is almost exclusively infective in origin. In this study an attempt was made to assess the importance of infective factors in relation to other possible causes, such as allergy and psychological factors.

MATERIAL AND METHODS

The group consists of a random sample of fifty asthmatic patients attending the Asthma Clinic, St. David's Hospital, Cardiff. The patients were unselected, and consisted of successive referrals to the clinic of asthma patients aged 60 years and over. For the purpose of this study, asthma is defined as recurrent attacks of dyspnoea with wheezing and prolongation of the expiratory phase and usually with intervening periods of freedom. Cases of cardiac asthma and dyspnoea secondary to intrathoracic or other disease were excluded. Each patient was investigated physically by a physician and specialist in allergy, and a specialist in oto-rhino-laryngology. Psychiatric investigation was carried out by the author without knowledge of the physical findings. The final aetiological assessment was based on discussion between allergist and psychiatrist, taking into account all the clinical and laboratory findings. A control group of similar age and sex distribution was investigated by the author and assessed by the same standards and criteria as the asthma group. The control group consisted of herniotomy and appendicectomy patients matched for age and sex with the asthma group.

AETIOLOGICAL ASSESSMENT

The methods of aetiological assessment have been described previously (REES, 1956). Aetiological factors were assessed as being dominant if they accounted for the majority of attacks, and subsidiary if they were found to precipitate some, but not the majority of attacks. A factor was assessed as unimportant if there was no evidence that it precipitated or exacerbated attacks of asthma.

CLINICAL DATA

There were twenty-two men and twenty-eight women. The age distribution was: 60–65 years, 58%; 60–70 years, 18%; 71–75 years, 20%; 76 years and over, 4%. The age of onset was distributed as follows: 0–15 years, 8%; 16–25 years, 6%; 26–35 years, 10%; 36–45 years, 16%; 46–55 years, 32%; 56–60 years, 10%; 61–65 years, 16%; 66–70 years, 2%. It can be seen that 60% developed asthma for the first time after the age of 45 years, and 18% over the age of 60 years. The group of patients with late onset (age 46 years and over) will be compared with those with earlier onset.

ASSESSMENT OF RELATIVE IMPORTANCE OF CAUSATIVE FACTORS AT TIME EXAMINED

Table 1 gives the distribution of aetiological assessments of allergic, infective,

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and psychological factors in the total group, and for the group subdivided into those with an onset before age 46, and those with a later onset. Psychological factors played an aetiological role in 78%, infective factors in 66%, and allergy in 30%. The findings do not therefore support the commonly held view that asthma in later life is predominantly infective in origin. As dominant causes, psychological and infective factors are similar in incidence, but psychological factors occur in a higher proportion as subsidiary causal agents giving a greater total incidence than infective factors.

TABLE 1.—AETIOLOGICAL ASSESSMENT

	Total group (50)		Onset before age 46 (20)		Onset 46 yr and after (30)	
	Number	%	Number	%	Number	%
Psychological factors						
Dominant	22	(44)	7	(35)	15	(50)
Subsidiary	17	(34)	8	(40)	9	(30)
Unimportant	11	(22)	5	(25)	6	(20)
Allergic factors						
Dominant	5	(10)	4	(20)	1	(3·3)
Subsidiary	10	(20)	4	(20)	6	(20)
Unimportant	35	(70)	12	(60)	23	(76)
Infective factors						
Dominant	23	(46)	8	(40)	15	(50)
Subsidiary	10	(20)	4	(20)	6	(20)
Unimportant	17	(34)	8	(40)	9	(30)

The group of patients with onset-age 46 years and later has a higher proportion of patients with allergy as dominant and subsidiary factors than the group with earlier onset, but the difference does not reach statistical significance. The incidence of psychological, infective, and allergic is similar in both groups.

THE DOMINANT AETIOLOGICAL FACTOR OPERATING AT THE ONSET

The main factor determining the onset of asthma is shown in Table 2.

TABLE 2.

	Total group		Patients with onset before 46 years		Patients with onset 46 years and later	
	(50)	%	(20)	%	(30)	%
Psychological	18	36	4	20	14	46·6
Infective	23	46	9	45	14	46·6
Allergic	4	8	3	15	1	3·3
Infective and psychological	2	4	1	5	1	3·3
Not known	3	6	3	15	0	—

It can be seen that psychological factors determined the onset in a statistical significantly higher proportion of patients with onset of asthma after 45 years than the group with an earlier age of onset (critical ratio = 2). Although there is some tendency for the main cause at the onset to continue to be the dominant cause during the course of the illness, this is not invariably so, and may later be superseded in aetiological importance by other causal factors. In fact, we find in this group, as in younger asthmatic groups, a large variety of sequences and combinations of aetiological factors. The actual distribution and various combinations of main causes at the time of examination are shown in Table 3.

TABLE 3.

Dominant factors	Subsidiary factors present						Other factors unimportant
	Allergy only	Allergy and infection	Allergy and psychological	Psychological alone	Psychological and infective	Infective only	
Infective (23)	3	—	2	12	—	—	6
Psychological (22)	3	2	—	—	—	6	11
Allergy (5)	—	—	—	1	—	2	2

Thus, 4% were solely allergic, 12% solely infective, and 22% solely psychogenic, giving 38% due to one main cause, with other factors being relatively unimportant. 62% therefore had more than one cause, and among these are 12% with all three main causes.

PSYCHOLOGICAL FACTORS OPERATING DURING THE COURSE OF THE ILLNESS

A clear relationship could be established between emotional state and precipitation of asthma attacks in 78% of the group. A variety of emotional states were found to be capable of precipitating asthma, the most common being anxiety and general tension. Others frequently acting as precipitants were anger, resentment, indignation, and feelings of humiliation. Even laughter and pleasurable emotional states not infrequently brought on attacks. If the patient's personality or external circumstances are such that emotions are suppressed or inadequately expressed, the tendency for attacks to develop was greater. The role of emotional changes in precipitating asthma in elderly patients is best understood when related to the person's adjustment problems.

ADJUSTMENT PROBLEMS IN LATER LIFE

Senescence is characterized by changes in constitutional status, including decrease in physical and mental efficiency and changes in neuro-humoral relationships and homeostatic functions. The decline in physical capacity is associated with an increased need for bodily care, and this, together with a decline in learning capacity, requires a readjustment in aspiration levels, attitudes, and behaviour. In addition, the elderly person has to adjust to changes in social role and status which may come with

old age. There are two particularly important changes which are specially associated with later life and which usually call for major readjustment. These are the loss of a marriage partner, or loss of employment. Both these happenings increase the need for companionship and may necessitate changes in housing arrangements, means of subsistence, and opportunities for passing one's time.

In some members of the group the adjustment problems associated with old age played an important role in the precipitation of asthma. For example, retirement coming too early or suddenly, or if it resulted in financial stress or is associated with failure to develop substitutive activities in other work, hobbies or recreations, created emotional difficulties which precipitated and exacerbated attacks of asthma. If the retirement is forced by asthma, this sometimes creates further problems, with an increase in emotional difficulties and further exacerbation of asthma. Some of the patients were fit enough to undertake light part-time employment after retirement, and when this was possible it greatly helped toward a better adjustment. In those patients of the group who were well adjusted to the changes associated with old age, it was unusual to find that emotional factors played a prominent role in their asthma. Reactions to stressful life situations not necessarily peculiar to old age were also found to play an important role in precipitating asthma in some patients.

PSYCHOLOGICAL FACTORS DETERMINING INITIAL ATTACK OF ASTHMA IN GROUP WITH ONSET AFTER 45

Table 2 shows that psychological factors were responsible for the onset in a statistically significantly higher proportion of cases having asthma for the first time after 45 years of age than those with an earlier age of onset. There were fourteen such patients (46·4%) compared with 20% in group with an earlier onset. The types of stress associated with the onset of asthma in these fourteen patients were as follows:

(1) Work and financial problems, four patients.
(2) Bereavement of marriage partner or near relative, three patients.
(3) Family worries, three patients.
(4) Miscellaneous, four patients.

REACTIONS TO LIFE SITUATIONS DURING THE COURSE OF THE ILLNESS.

Similarly, in the total group during the course of the illness, asthma was in some patients clearly precipitated by sudden stress, such as the death of a spouse, relative, or friend, or the threat to the security of loved persons by illness, accident, or other causes. Prolonged stress was found to be important in precipitating asthma in some patients, such as family and marital problems, financial or employment worries. Adjustment difficulties to the changes of senescence, as well as other stresses, not only may give rise to states of emotional tension which result in the precipitation of asthma, but may also be manifested in neurotic symptoms.

THE INCIDENCE OF NEUROSIS AND NEUROTIC SYMPTOMS

Nearly one-quarter of the group were suffering from psychiatric symptoms of sufficient severity to warrant a diagnosis of neurosis. These were nine patients with anxiety state and two with reactive depression. Two patients had a marked hysterical overlay to their symptoms. There were no cases with a frank neurosis in the control group, but some had neurotic symptoms. Four controls had symptoms of moderate anxiety, one of severe anxiety, and two with a moderate degree of depression. The incidence of neurosis in asthmatic patients is thus significantly higher than the control group. The neuroses found in our group were of multiple causation, with individual predisposition in varying degrees interacting with environmental stresses.

The neuroses of senescence represents patterns of attempts at adjustment to interpersonal and environmental difficulties. Individuals vary in their capacity of adjustment to the changing constitutional and biological status of senescence, to the changed environmental relationships, and the role the old person is expected to play. The increasing rigidity, conservatism, and gradual restriction of interests which tend to occur in senescence makes adjustment to changes more difficult. The success with which adjustment proceeds will depend on the patient's previous personality and stability as well as the degree of stress the person has to contend with. Stress and pressures incidental to old age do not fall equally on all people; personal susceptibility and vulnerability have to be taken into account. In this group the tendency to develop neurosis was partly constitutional, as evidenced by a family history of neurosis, and a history of previous neurotic illness and instability of personality, and partly due to environmental difficulties.

PERSONALITY

The theory that asthma is associated with specific type of personality has been held for many years. The patients were rated on a three-point scale with regard to a variety of personality traits, and compared with the control group rated by identical standards. This is shown in Table 4.

The following differences are statistically significant: asthma patients' higher

TABLE 4.—PERSONALITY RATINGS

	Asthma (%)	Controls (%)
General stability		
Stable	66	86
Moderately unstable	24	14
Very unstable	10	0
Meek, timorous		
Not	56	52
Somewhat	36	44
Very	8	2
Sensitive		
Not	38	38
Somewhat	12	18
Very	50	44
Anxious		
Not	26	36
Somewhat	16	18
Very	68	44
Meticulous, obsessional		
Not	46	40
Somewhat	20	28
Very	34	30
Schizoid	8	8
Cyclothymic	14	12
Hypochondriacal	16	2

incidence of moderately and very unstable individuals (C.R. = 2·4), very anxious persons (C.R. = 2·4), and those with hypochondriacal traits (C.R. = 2·4).

PREDISPOSITION TO ASTHMA AND ALLERGIC DISORDERS

The question of a genetic predisposition to asthma is controversial. SCHWARTZ (1952) found strong evidence in favour of a hereditary basis to asthma irrespective of whether it was of allergic origin or not. In this group there was an incidence of asthma, vasomotor rhinitis, and flexural eczema in parents and siblings in 32% of asthmatics compared with 10% in the control group. The difference is statistically significant (critical ratio = 2·8). This finding is in keeping with that for younger asthmatics (REES, 1956), and supports the result of the investigation of SCHWARTZ (1952).

ASSOCIATION WITH OTHER PSYCHOSOMATIC DISORDERS

The question of specificity of response to stress is one of the fundamental problems in psychomatic medicine. In this connection it is particularly important to consider the association of asthma with other "stress disorders" in the same patient. The following disorders were found: migraine 8%, coronary disease 4%, hypertension 4%, peptic ulceration 4%, neurodermatitis 2%, and spastic colon 2%.

As an example of multiple disorder in response to stress, may be quoted the patient who had severe emotional shock when her sister was blown into a canal on a stormy night, and drowned. Following this, the patient developed asthma, neurodermatitis, and a depressive state lasting nine months. Another patient, following his wife's death, developed asthma and duodenal ulcer. Two patients showed a similar pattern of reaction to stresses by first developing migraine, immediately followed by asthma.

Thus, in a number of patients in the group the evidence is against a specificity of organ response to stress.

INTER-RELATIONSHIP OF VARIOUS CAUSATIVE FACTORS IN ASTHMA

Reference to Table 3 shows that 62% of patients had more than one of the three main factors playing an aetiological role, and in 18% allergic, infective, and psychological factors played a part in the causation of asthma. Clinical evidence suggests that allergic, infective, and psychological causal factors are not independent and merely co-existent. There is evidence that these factors interact and may be additive in their effects. For example, one of our patients, who had suffered for many years from frequent attacks of bronchitis without any accompanying asthma, developed asthma with her bronchitis during a period of emotional stress. This occurred when her daughter had an illegitimate baby, which the patient had to care for to enable the daughter to go out to work to support the family.

In some patients in whom the onset was precipitated by emotional stress there was evidence of previous allergic disorder. For example, a patient age 69 who developed asthma at the age of 55 immediately after her mother's death, suffered from hay fever earlier in life, and her son also has hay fever. Psychological, allergic, and infective factors will sometimes only produce asthma by their summative effects. A possible psychological basis for this interrelationship between various causative factors mediated by the autonomic nervous system is discussed by REES (1956).

The summative effect of various causative agents in producing asthma has important therapeutic implications, and indicates the importance of attempts to alleviate as many of the causes as possible. Even if one aspect, e.g. emotional difficulties, can be helped, this might not only alleviate attacks emotionally precipitated, but also those brought about by the summative effects of psychological with infective or allergic factors.

SUMMARY AND CONCLUSIONS

(1) A random sample of fifty asthmatic patients aged 60 years and over was investigated from physical and psychological aspects, together with a control group of fifty subjects assessed by the author, using the same standards and criteria.

(2) The commonly held view that asthma in elderly patients is almost invariably infective in origin was not supported by the results of the investigation. Psychological factors were found in 78%, infective factors 66%, and allergic factors in 30%.

(3) Patients with a late onset had a higher incidence of psychological factors as the dominant cause than those with an onset before 45 years.

(4) The onset of asthma was determined by psychological factors in 36%, and a combination of infective and psychological factors in 4%.

(5) The main cause at the onset was not invariably the dominant cause during the course of the illness. In 62% more than one main causative factor was aetiologically important, and in 12% all three main factors were in operation. Infective, allergic, and psychological factors occurred in varying sequences and combinations.

(6) No specific personality type was found, but certain traits occurred in significantly higher incidence in asthmatics than controls. These traits were such as to be conducive to the development of states of emotional tension.

(7) The family history of asthma and related disorders was significantly higher than in the control group.

(8) A demonstrable association between emotional changes and precipitation of asthma was found in 78%.

(9) A definite neurotic illness was found in 25%. The relevance of neurosis and adjustment problems to asthma in elderly patients is discussed.

(10) Various life situations which were stressful to the individual were found to be associated with the onset, precipitation, or aggravation of attacks of asthma. Of particular importance were death of, illness of, or accident to loved persons, family problems, and adjustment difficulties to changes of senescence, particularly following retirement. Persons who were well adjusted to changes associated with old age were found to have emotional factors precipitating asthma infrequently.

(11) Interesting relationships were observed between infective, allergic, and psychological factors, indicating summative effects.

(12) The investigation indicates that asthma in elderly persons is a disorder of multiple causation in which various causal agents operate in different combinations and sequences in different individuals. Psychological and infective factors occupy a much more important role than allergy in this group.

Person-environment interactions are of paramount importance in the understanding and treatment of asthma in elderly patients, and due regard must be paid to the special adjustment difficulties arising in later life.

Acknowledgement—The author has pleasure in thanking Dr. D. A. WILLIAMS, Physician in Charge of Asthma Clinics, St. David Hospital, Cardiff, for his kind co-operation and for providing facilities for the study.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 219 to 226. Pergamon Press Ltd., London

BODY-WEIGHT CHANGES IN PSYCHIATRIC ILLNESS

A CRITICAL SURVEY OF THE LITERATURE

FELIX POST, M.R.C.P.

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INTRODUCTION

AFTER surveying, critically, recent studies of bodily physiology in mental and emotional disorders, ALTSCHULE (1953) remarks: "Observations made by physiologists and psychologists on bodily changes in emotion show that there is no rigid parallel between the occurrence and degree of physiologic change and the occurrence and degree of emotion that the subject shows or says that he feels. On the other hand, some physicians (including psychiatrists) who have made similar studies have commonly reported close—even exact—correlations between the two. No progress in the field can be expected until this difficulty is resolved."

The striking changes in body-weight seen in psychiatric patients during the course of their illness, and especially during recovery, are hardly considered in ALTSCHULE'S book. This is surprising, as here we have for once a well authenticated example of psychological and bodily changes running in parallel; but the gap separating the views of different investigators concerning the causation of these weight changes is similar to the one shown up by ALTSCHULE in the field of bodily changes in emotion.

In many psychological illnesses, weight gains and losses are clearly the result of changes in food intake due to alterations of appetite; the most striking example is furnished by the anorexia nervosa syndrome. Similarly, many cases of obesity are due to overeating as an expression of emotional disorder, and the literature on this subject has been reviewed by SHORVON and RICHARDSON (1949). In this review we shall only be concerned with weight changes alleged to occur in psychiatric illness independent of changes in food intake, weight changes which by some writers have been called "endogenous," by others "paradoxical."

1. WORK CLAIMING THE OCCURRENCE OF ENDOGENOUS WEIGHT CHANGES

Most clinical writers assume tacitly or state explicitly that variations in body-weight in the course of psychiatric illnesses are only partly due to food refusal and agitation, and are largely caused by the same disturbances of biological (cerebrally localized) function which are also held responsible for the production of the mental symptoms of the psychosis. In fact, weight changes are allegedly most prominent in patients with confirmed organic psychoses or psychiatric illnesses often regarded as related to them. Computing the percentage deviation from the expected body-weight of 925 adult male mental patients, BRENNAN (1945) found that cases of organic brain disease with mental disturbances showed a statistically significant greater average loss of weight than patients in all other diagnostic categories, including psychotics known for their

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propensity towards food refusal, such as catatonics and depressives. KRYSPIN-EXNER (1947) sought to demonstrate that weight variations were more extensive and abrupt in catatonics than in manic-depressives, and that this finding lent support to the assumption that a more serious disturbance of basic biological processes takes place in schizophrenic illnesses. Both NOBEL (1936) and KALINOWSKY (1948) claim that weight loss in "reactive" (neurotic) depressions is trivial as compared with that seen in "endogenous" ones.

ROSENFELD (1906) seems to have been the first modern investigator of the relationship between weight changes and food intake in psychotic patients; he reviewed the already extensive literature on metabolic changes and abnormalities in the psychoses which had appeared since NASSE's (1859) paper reporting the great variability of body-weight, without paying any attention to the role of food and fluid consumption or of urinary excretion. ROSENFELD's paper is favourably distinguished from much subsequent work by containing numerical statements in tabulated form; he reports on tube-feeding experiments with a small number of catatonics who were refusing food. One of them died after a further drop in the weight curve in spite of tube-feeding; two patients did gain a little, but this was thought to have been due to increased water retention; this gain in weight was in any case negligible in comparison with that which occurred later on during recovery. Failure to gain weight to any appreciable extent during tube-feeding (3000–4000 cal daily) was attributed by ROSENFELD to a disturbance in the regenerative capacity (Regenerationsenergie) of the tissues in some psychoses. REICHARDT (1918) expressed the opinion that a cerebral centre, probably situated in the brain stem, regulating water metabolism was responsible for keeping the body weight in health constant over many years in spite of variations of food and fluid intake. While this centre was intact, changes in weight could only be produced by exogenous factors, of which the most important were changes in the quantity of ingested nourishment and the amount of muscular exercise. These exogenous factors were also operative in patients with cerebral disorders (and here this writer included the functional psychoses), but there were cases where the weight-loss was predominantly due to endogenous causes, e.g. cases of stupor in whom there is allegedly great loss of weight in spite of over-feeding. Whether or not a psychosis was associated with weight changes might depend on the localization of the "process" in the brain, either sparing or affecting the weight-regulating centres; for this reason in different cases of schizophrenia there might be either great loss or gain of weight. In manic-depressives there may also be "endogenous" weight changes, and this is especially so in severe and long-continued illnesses, but REICHARDT did not belittle the role played by food-refusal and motor over-activity. From a study of weight charts and course of 190 mental hospital patients, REHM (1920) drew several conclusions; among them that variations of weight in manic-depressives did not run in parallel with the affective variations, but with the psychomotor behaviour; strangely enough, he does not interpret this in terms of weight-loss through increased exercise, but suggests that the autonomous course of the weight changes signifies that it is due to metabolic and hormonal disturbances underlying the psychoses, the affective disturbances and variations being relatively unimportant surface phenomena. A little more recently, NOBEL (1936) in a doctoral thesis using the cases of the Basle clinic, sought to demonstrate that exogenous causes for weight changes (food intake, amount of physical exercise), though often demonstrable, are less profound and

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important than "primary endogenous fluctuations in a centre regulating metabolism." Though based on the records of 50 manic-depressives and 70 schizophrenics, this investigation suffers severely from the writer's reluctance to employ statistical methods.

The unsatisfactory nature of previously published work on account of its failure to employ quantitative and statistical methods is stressed by ALSTROEM (1943) in his monograph on the weight fluctuations of mental patients using the records of 1666 inmates of a Swedish hospital. Much of the work reported is irrelevant to our problem; ALSTROEM demonstrated that weight fluctuations in psychotics are far beyond anything seen in the weight charts of normals (obtained from a public bathing establishment), and he found that considerable fluctuations in weight were most frequently found in manic-depressives, arterio-sclerotics, general paralytics, and catatonics, but that they also occurred to an abnormal degree in "psychopaths." The author is especially concerned with schizophrenics, and concludes that the great fluctuations in weight, seen especially in catatonics, indicate that schizophrenia is caused by a cerebral disturbance, the brain being either primarily or secondarily affected. He then goes on to an attempt to eliminate refusal of food and the presence of pulmonary tuberculosis as revealed by radiography as causes for the variability of body-weight. Using "Rohrer's Index of Body Volume" and the method of analysis of variance in a group of catatonics subdivided into those who did and those who did not refuse food, and those with and those without positive chest X-rays, he found that refusal of food did seem to play a certain role in lowering the body-weight of female catatonics, but that it had only statistically insignificant influence on the weight-loss of male catatonics. He suggests that the reason for this difference may be that females tend to be more frequently overweight, possess more subcutaneous fat, and probably retain relatively more water in their tissues. There was no significant correlation between weight changes and the presence or absence of pulmonary tuberculosis. ALSTROEM concludes that tuberculosis and refusal of food are not the main causes of weight-loss in catatonics, but that changes in body-weight are directly caused by the catatonic (i.e. cerebral) disturbance. He does not deny that in normal people weight-loss can be produced by food refusal and "banting," but he thinks that these changes are nothing like as profound as in psychotics. (One wonders whether this author may not have changed his opinion since seeing the pictures of the Belsen victims.) KALINOWSKY (1948) draws on material "based on observations made on many hundreds of patients," but he states that "the statistical approach so valuable in research in general was purposely avoided because it was felt that individual observations might lead to new ideas which later on can be statistically controlled." His study is mainly concerned with patients who showed mental improvement with convulsive therapy, and the author states that he found again and again that patients lost weight in spite of regular food intake, but that, on the other hand, gain of weight during the period of recovery was achieved in spite of poor food during wartime hospital conditions. "All the available evidence indicates that no external factor is responsible for the variations of weight [in the psychoses]." Linking up weight fluctuations, menstrual disturbances, and sleep changes, KALINOWSKY hints at the central role of the diencephalon in affective and schizophrenic psychoses.

Turning briefly to the related subject of abnormal weight-gain, there are also a number of reports which claim that sudden obesity has been observed following psychological stress and without over-eating. The most striking account comes from

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GILBERT-DREYFUS (1948), who described a syndrome of gain in weight and obesity of the trunk occurring especially in women after severe experiences during the last war. After the collapse of France in 1940, "une veritable épidémie d'embonpoint" is alleged to have been observed. He stressed that this condition occurred at a time of general under-nourishment or in circumstances (prison camps) where no surreptitious eating was possible. SHORVON and RICHARDSON (1949) thought that, in some of their cases of pathological obesity treated with an abreactive psychotherapeutic technique, considerable reduction of weight was produced without changes of diet.

Looking back at this point of our review, it is apparent that there is a considerable body of clinical opinion which holds with great conviction that weight changes in psychiatric illness are only in part caused by refusal or over-indulgence in food, and that endogenous weight fluctuations, due to action on a weight-regulating centre or process by the same pathological events which produce the psychiatric picture, are more important. But this reviewer could not help noting that most of the observations on which this opinion is based, were not made with scientific precision, and that statistical methods were either avoided or employed too near the limits of their applicability.

2. CLINICAL WORK DENYING THE OCCURRENCE OF ENDOGENOUS WEIGHT CHANGES

Comparatively few clinicians have demonstrated that weight changes in mental illness are due solely to an increased or diminished intake of foods or fluids. COLEMAN (1944) described a group of patients who presented with emaciation as their leading symptom; they lacked a depressive affective disturbance or thought content, but had depressive personalities; all of them had dietary problems, such as fads and food rituals, and their inappropriate nutrition appeared to be the cause of the weight-loss. Turning to more severely ill patients, we find that GJESSING's (1932, 1935) unrivalled studies on the metabolism of periodic catatonics did not concern themselves primarily with weight changes, but his records and charts demonstrate very clearly that the weight of his patients was held at a practically unchanged level throughout the studies by keeping constant the intake of food and fluids, as well as by eliminating all intercurrent infections; only one patient lost 1–2 kg in one phase during 24–48 hours; this occurred while urinary output was diminished, and was attributed by GJESSING to extrarenal excretion of water. Repeating GJESSING's investigations, HARDWICK and STOKES (1941) found a steady gain in the weight of their patients in the first part of the experimental period until it had reached an optimum (presumably the investigation had led to better general care): after that the weight remained steady through several phases of the catatonic disorder.

Turning to obesity, BRUCH (1940) noted that in about 20% of 142 obese children, over-eating was denied, but that further study clearly revealed its occurrence. In a later publication (1943), she summarizes: "Though over-eating was often vehemently denied by the fat children and their parents, the actual intake was always in excess of that of normal children." In a group of women who came under psychiatric care largely because they were unable to reduce their weight or to maintain any weight-loss achieved, searching enquiry either revealed over-eating, or over-indulgence in only one or two types of fattening food, or eating between meals. According to the author (HECHT, 1955), the obesity was in fact due to an "eating addiction," which on the

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basis of the psychotherapeutic work done with these patients is explained along psychoanalytic lines.

Recently, PARIN (1953) found among 377 schizophrenic patients of the Burghoelzli Clinic only 6 clearly obese and 5 abnormally thin patients (i.e. deviating by more than 10% from their ideal weights). These 11 patients were weighed several times and subjected to a variety of laboratory examinations, including estimations of the B.M.R. Intake of food was recorded during three days, and the feeding habits of the patients were closely observed. After balancing intake against output, it was found that all obese patients clearly consumed more calories than they used up; emaciated patients either showed a negative nutritional balance, or had bizarre dietary habits, or suffered from previously undiagnosed physical illnesses. In some cases there were also signs of endocrine imbalance, but in none of the patients was there any evidence to suggest that weight changes were due to a direct action of the psychotic state on a central weight-regulating centre. Instead, it emerged that the psychotic behaviour had strongly influenced food intake, and in addition most of the patients had shown disorders of the nutritional drives since childhood. "We suggest that a schizophrenic disorder may disturb the natural regulation of food intake to such an extent that it is no longer governed by feelings or appetite and hunger. In this way, the number of calories ingested often ceases to correspond with the subject's requirements, and extreme deviations from a normal nutritional status are produced."

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3. EXPERIMENTAL WORK

In the work of physiologists and physiological psychologists, we find reference to appetite and gastric function during emotional disturbances, but none to variations of body-weight. Weight is discussed by DUBOIS (1936) in relation to malnutrition and obesity, but not in connection with mental diseases, where he largely refers to the work of GRAFE and his collaborators. GRAFE (1923) was impressed by accounts of normal people (including a doctor subjecting himself to metabolism experiments) losing weight in spite of an allegedly undiminished diet on account of an anxious state of mind. He pointed out that with food intake and muscular exercise held constant, weight-loss could only be explained by an increased rate of metabolic processes. Practical difficulties deterred him from determining in mentally ill patients, whether the psychological disturbances present did, in fact, evoke increased metabolic rates. Instead, he and MAYER (1923) determined the rates of metabolic exchanges in ten normal young subjects at first during hypnotic trance, and then during a hypnotic state while depressive themes and affects were suggested. It was found that during "depressive hypnosis" there was an average rise of metabolism by 7·6%, the increase in one case being 25%; pleasurable affects suggested in two cases produced a much smaller rise of metabolic rate. These workers felt that their results supported the assumption of weight-loss occurring in depressive illness in spite of adequate food intake on account of a raised metabolic rate. But since then there have been numerous reports on the basal metabolic rate in a variety of psychiatric illnesses. They have been summarized by CAMERON (1941) and again by ALTSCHULE (1953): in most instances of neurosis and psychosis, basal metabolic rates have been reported as low or normal; occasional high rates were always connected with hyperactivity or tension, but "feelings of agitation *per se* do not increase the metabolic rate." There do not appear

to exist any reports on comparing serial basal metabolic ratings with variations of body-weight during the course of a psychosis.

Weight-loss in spite of an unchanged diet might be the result of failure of absorption from the gastrointestinal tract. Reports of abnormal gastrointestinal motility, stasis, and disordered secretion in various mental disorders have appeared from time to time (summarized as "Unimportant" by ALTSCHULE, 1953), but no references have been found suggesting defective absorption of ingested foods.

Ill-nourished psychotics are frequently also dehydrated; over and above, there is some evidence that, not depending on fluid intake, water metabolism may be disordered. This possibility was investigated by HOFF and POETZL (1930) in some periodic psychotics by directing diathermy alone or in combination with various diuretic drugs to the midbrain; during the psychotic phases the amount of diuresis thus produced was smaller than during normal phases. They suggest that the diencephalic apparatus which regulates water metabolism remains set at a fixed level during the disturbed phase of a periodic psychosis, and is more resistant to drug and other stimulation than during the quiescent psychological phase. These experiments do not seem to have been repeated, but ALTSCHULE *et al.* (1948, 1949) investigated the nature of fluid exchanges in tissues and plasma in depressed patients gaining weight rapidly during electroconvulsive therapy. They suggested that the gains from 1·3 to 2·3 kg (maximal observed gain being 6·4 kg) could not be due to the correction of dehydration alone. Using a modification of the thiocyanate method, the values of extracellular fluid volume in a group of melancholic patients were found to be in the lower part of the range obtained in normal subjects, and the gain in weight which occurred in association with the onset of improvement during electroconvulsive therapy was accompanied by an increase of volume of extracellular fluid. With small increases in weight early in the course of therapy, the weight of the extracellular fluid gained was not significantly different from the gain in weight exhibited by the patient as a whole, but after a longer course of shock-therapy the increase of extracellular fluid volume was less than the gain in weight, and it therefore appeared to these workers that new protoplasm was formed as well (presumably derived from an increased food intake).

4. CONCLUSIONS

In this review of the literature an attempt has been made to present the evidence for and against the occurrence of endogenous weight changes in psychiatric patients. The reader may have shared the reviewer's disappointment at discovering how little scientifically controlled experimental work has been done to elucidate the mechanisms governing body-weight alterations in the psychoses, to which, as clinicians, we attach so much significance. It is surprising that nobody appears to have attempted the obvious, viz. to measure over a period the food intake and metabolic exchanges in recurrent melancholics, who are known to exhibit profound changes in weight during each attack. The only quantitative experimental work encountered was that of ROSENFELD (1906) with tube-fed stuporose catatonics, and the observations of GJESSING (1932, 1935) and HARDWICK and STOKES (1941) on periodic catatonics. But while in ROSENFELD's cases weight-loss continued in spite of high-calorie feeds, weight changes were prevented by keeping the diet constant in the periodic catatonics.

We commented earlier on the dubious value of much of the work supporting along

speculative or statistical lines the occurrence of direct action by the psychotic disorder on a weight-regulating mechanism. Subsequently, we summarized clinical work of a more critical and discerning kind, which went a long way towards showing that all fluctuations in body-weight observed in psychiatric patients could be satisfactorily explained by deviations in eating habits and disturbances of appetite, alone. Changes in water metabolism have been demonstrated in the course of psychoses, but the weight fluctuations produced by these mechanisms are usually too small to account for the considerable weight changes observed in many mental patients. Probably, these changes in water metabolism are only one of the many neuroendocrinological events described in response to various kinds of stress. ALTSCHULE *et al.* (1949) point out that the increase in extracellular fluid volume observed after electroshock treatment was reminiscent of the action of some steroid hormones, but that administration to depressed patients of desoxycorticosterone or progesterone, steroid hormones which may affect retention of salt and water, has no beneficial effect.

Fluctuations in weight, which might be called paradoxical because occurring with unchanged food intake, have been raised to the status of self-evident clinical facts by many workers. These endogenous weight changes have been used as evidence for a central weight-regulating mechanism coming under the influence of a brain-located psychotic process. This review indicates that the onus of proof for the existence of endogenous changes of body-weight remains with the proponents of their occurrence. In the meantime, the deviations of food drives and of appetite in the course of psychiatric disorders would seem to offer a more promising area of enquiry by workers concerned with psychophysical relationships.

Acknowledgement—My thanks are due to Dr. I. C. LODGE-PATCH for supplying some of the references.

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LETTER TO THE EDITORS

Idiopathic Glossodynia (Burning Tongue)

THE undersigned are investigating the psychosomatic and psychodynamic aspects of the problem of idiopathic oro-lingual paresthesias, and particularly idiopathic glossodynia (burning tongue), in which cases the histories and repeated oral examinations are always negative, as are the laboratory findings. These factors lead us to believe that this frequently seen syndrome (five new patients per week, perhaps, in our clinic) has a psychosomatic origin and requires psychotherapeutic measures for elimination.

However, owing to the sometimes transitory character and lack of severity of the disease, psychiatric clinics are unwilling to treat these cases on an experimental basis without charge. In addition, the reluctance of such patients to pay for such therapy privately or to entertain the thought of commencing psychotherapy has prevented a study of the effectiveness of psychotherapy in eliminating the symptoms of this disturbance.

This letter is written with the hope that psychotherapists reading this appeal will co-operate with us to the extent of supplying us with information relative to findings in patients now under treatment in their practice who have "burning tongue" symptoms. We realize, of course, that in nearly all instances the burning tongue would be only one of a group of complaints for which the patient is being treated. However, *we* are focusing our attention on this aspect of the syndrome.

We would therefore be most appreciative if any physician having such a patient now or previously under treatment would advise us of this fact together with whatever brief information he may feel is pertinent as to history, physical examination, course of illness, therapy, and results.

We are interested particularly in the psychodynamic aspects of this somatization reaction; whether the therapist felt it was primarily one more manifestation in an oral personality or whether the symptoms appeared as a regressive defence against other instinctual conflicts. We are aware that this is just one of the components in a psychopathologic constellation, but its frequency warrants investigation.

With the above information we hope to be able to better describe the syndrome of idiopathic glossodynia and ascertain the efficacy of psychotherapy for patients presenting this problem—one of great consequence to those practitioners whose chief area of concern is the oral cavity. This importance can be demonstrated both in terms of numbers of patients and the severity of the complaints as expressed by them.

Through the courtesy of the editor, we have been permitted this means and opportunity to appeal to the readers of the *Journal of Psychosomatic Research* to make available any such case histories as they may be willing to place at our disposal. Of course, all such information as to the source from which it emanated will be suitably acknowledged in the publication which we hope will result from this study.

Kindly address your reply to Dr. AUSTIN H. KUTSCHER, School of Dental and Oral Surgery, Columbia University, 630 West 168th Street, New York 32, New York.

CARLOS J. DALMAU, M.D.
AUSTIN H. KUTSCHER, D.D.S.

Columbia University
New York, N.Y.

Journal of Psychosomatic Research, 1956, Vol. 1, pp. 228 and 229. Pergamon Press Ltd., London

CONFERENCES

THE Second European Conference on Psychosomatic Research was held in Amsterdam from 17 till 21 April 1956. Ninety workers from Austria, Belgium, Denmark, Finland, France, Germany, Great Britain, Greece, Italy, Spain, Sweden, Switzerland, and the Netherlands took part in the meeting. Professor ERICH LINDEMANN was a welcome guest speaker from the U.S.A.

The programme was as follows:

THE PHILOSOPHICAL AND PSYCHIATRIC BASIS OF PSYCHOSOMATIC MEDICINE

Prof. Dr. L. VAN DER HORST, Professor of Neuropsychiatry, Amsterdam.
J. O. WISDOM, Reader in Logic and Scientific Method, London.
Dr. J. ROF-CARBALLO, Physician, President of the Psychosomatic Society of Spain, Madrid.
Prof. E. LINDEMANN, Professor of Psychiatry, Boston, Mass., U.S.A.
The psychogenic factor in the aetiology of diseases. Prof. Dr. A. JORES, Professor of Medicine, Hamburg.
Psychosomatic medicine and the concept of disease. Prof. Dr. G. A. LINDEBOOM, Professor of Medicine, Amsterdam.
Dr. P. LABBÉ, Psychiatrist, Brussels.
Dr. G. BIÖRCK, Asst. Professor of Medicine, Malmö.
Dr. A. POSLAVSKY, Psychiatrist, Utrecht.

PSYCHOSOMATIC ASPECTS OF ARTERIAL HYPERTENSION

Present theories about the aetiology and pathogenesis of essential hypertension. Prof. Dr. TH. VON UEXKULL, Professor of Medicine, Giessen.
Bloodpressure changes under emotional influences in patients with essential hypertension. Dr. J. HAMBLING, Consultant Psychiatrist, Canterbury.
Central regulation of arterial hypertension. Dr. M. SAPIR, Assistant in Medicine, and Dr. J. Stroun, Paris.
Psychosomatic problems in experimental hypertension. Dr. SCHUNK, Lecturer in Medicine, Würzburg.
Reserpine in hypertension and in psychosomatic practice and research. Dr. F. ANTONELLI, Physician, Rome.
Bloodpressure changes under emotional influences. Dr. J. M. VAN DER VALK, Physician, Amsterdam.
Successful treatment of a case of malignant hypertension. Dr. SIMONE DURET-COSIJNS, Psychiatrist, Brussels.
Dr. G. S. PHILIPPOPOULOS, Psychiatrist, Athens.
Dr. P. LABBÉ, Psychiatrist, Brussels.

SURVEY OF ACTIVITIES OF THE PSYCHOSOMATIC RESEARCH UNIT AT THE WILHELMINA-GASTHUIS

Introduction. Dr. J. GROEN, Physician-in-chief.
Syndrome displacement in psychosomatic medicine. Dr. J. BASTIAANS, Psychiatrist.
Some results of psychological research in psychosomatic medicine. Dr. J. T. BARENDREGT, Psychologist.
Case demonstration. Dr. J. GROEN.
Group-psychotherapy of bronchial asthma. Dr. H. E. PELSER, Physician.

ANIMAL BEHAVIOUR AND PSYCHOSOMATIC MEDICINE

Introduction. Dr. J. GROEN.
Prof. Dr. G. P. BAERENDS, Professor of Zoology, Groningen.
Dr. S. A. BARNETT, Lecturer in Zoology, Glasgow.
Dr. A. KORTLANDT, Animal Psychologist, Amsterdam.

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BODY-BUILD, CHARACTER, AND DISEASE

Dr. R. W. PARNELL, Physician, Oxford.
Dr. D. BROUWER, Physical Anthropologist, Amsterdam.
Dr. G. WRETMARK, Psychiatrist, Lund.
Dr. J. M. TANNER, Physiologist, London.
Physique in effort syndrome and in asthma. Dr. LINFORD REES, Psychiatrist, London.
Dr. A. STENBÄCK, Helsingfors.
Contributions of neuropharmacology to psychosomatic research. Prof. Dr. J. J. LOPEZ IBOR, Professor of Psychiatry, Madrid.
Endocrine-psychosexual relationships. Dr. G. BENEDETTI, Psychiatrist, Zürich.

FREE COMMUNICATIONS

Emotions, life situations, and thyrotoxicosis in Greece. Dr. G. S. PHILIPPOPOULOS, Athens.
Anorexia nervosa. Dr. BERTHA SOMMER, Heidelberg.
Stress and pain. Dr. DESMOND O'NEILL, London.
The use of plethysmography in psychosomatic research. Dr. B. ACKNER, London.
Psychosomatic aspects of the peripheral angioactivity. Prof. Dr. C. L. CAZULLO, Milan.
The influence of our time on psychosomatic diseases. Dr. E. RINGEL and Prof. Dr. H. HOFF, Vienna.
The role of precipitating factors. Dr. G. F. VAN BALEN, s-Hertogenbosch.
Psychological analgesia in obstetrics. Dr. L. CHERTOK, Paris.
Psychosomatic aspects of painless childbirth. Prof. Dr. R. SARRÓ, Barcelona.
Psychosomatic (experimental) approach to bowel disorders in children. Dr. E. J. ANTHONY, London.
Peptic ulcer. Dr. HØJER-PEDERSEN, ROSKILDE, Denmark.
Bronchial asthma and psychosis. Dr. P. J. REITER, Copenhagen.
Age and sex factors in asthma. Dr. L. REES, London.
The experimental study of psychoendocrine relationships. Dr. J. H. REY, London.

A business meeting was held on Saturday, 21 April.

An invitation was received from the Danish members for the 1957 Conference to meet in Denmark, and this was enthusiastically accepted. Dr. POUL KIRKETERP, Horsens Hospital, Horsens, Denmark, agreed to be responsible for the organization of this 1957 meeting. A decision as to the formation of a European association for psychosomatic research was deferred for further consideration at the 1957 meeting.

BOOK REVIEWS

ROLAND PIERLOOT **Problèmes Généraux de Psychosomatique Clinique.** Editions Nauwelaerts, Louvain, Belgium. Pp. 281. £1. 12s. 4d.

THIS is an excellent book Dr. PIERLOOT has written, a comprehensive, tolerant, and thoughtful account of the present position in the field of psychosomatic medicine. I know of no better exposition within such a modest framework of 229 pages of text. There is much that is familiar to the English reader: chapters on psychophysiological correlates, psychoanalytic interpretations, and clinical studies are competently handled. The neuroanatomical and endocrinological bases of the emotions are also discussed in familiar terms. It is the chapters concerned with the anthropological and philosophical concepts, now so popular in Europe, which are of particular interest to this reviewer. Whatever their merits, it behoves the research worker to be familiar with different concepts in this field, and in his book Dr. PIERLOOT has succeeded in giving a succinct account of what are two difficult and controversial subjects. Current American and British work perhaps takes too little account of these approaches, previously, certainly for the reviewer owing to an inability to comprehend, or even to sympathize with them. There is less excuse now, and I, for one, am grateful to Dr. PIERLOOT for his exposition.

Technically, the book suffers from the annoyance of uncut pages. The index is very poor, and the index of authors is so full of errors that it is unusable. Attention to this will be obligatory if further editions are contemplated. These are minor criticisms of an otherwise excellent book.

DENIS LEIGH

Prof. MEDARD BOSS: **Einführung in die Psychosomatische Medizin.** Medizinischer Verlag Hans Huber, Bern und Stuttgart, 1954. Pp. 223. £1. 12s. 4d.

THERE are two ways of dealing with the problems of psychosomatic medicine: detailed scientific research or sweeping philosophical enquiry. The author, who lectures on psychotherapy at the University of Zurich, has no hesitation in choosing the second way. The questions he asks, and the answers he gives, are philosophical. The traditional scientific approach is firmly rejected. Science, so the argument runs, reasons in terms of entities that have no real existence. There are no such entities as body and mind, and it is futile to search for mechanical causal relationships between them.

The few references from the scientific literature on psychosomatic medicine, which are quoted in the book, are dismissed as totally inadequate. It is claimed in fact that this is the first book to deal with the true nature of psychosomatic problems. The essence of disease, the author says, is the impairment of human existence. To understand disease, therefore, we have to understand human existence.

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But what is human existence? The answer is found in the existentialist philosophy of MARTIN HEIDEGGER to whom the book is dedicated. It is difficult to explain this philosophical system in English. There is no doubt that the German language is the more handy tool when it comes to the expression of abstruse thought by means of verbal dexterities which are untranslatable.

The teaching of existentialist philosophy as presented by the author and understood by the reviewer seems to be this. Man is not just an object among other objects; he is not a mere organism composed of physical and psychological elements; nor is his true being revealed when he is aware of himself as an object that thinks of, and deals with, objects in the environment. It is only when man forgets himself, only when he loses himself in comprehending and manipulating objects, that he can be said to have achieved that existence which unfolds to him the great mystery of the essence of things.

This existence, this "Da-sein", this "being-in-the-world", turns out to be a metaphenomenal Jack of many trades. There are many forms of existence which are potentially available to man. But they all have to pass through the media of body and mind in order to gain contact with the world of things. A man may avoid some forms of existence, or his life situation may refuse them an outlet. If this happens, if existence cannot pass freely through the medium of the body to the things of the world, it may become stuck in that medium and thus give rise to functional disorders. To quote: "This arrest within the own body of existential potentialities of human life is the basis of *all* hysterical and *some* organ-neurotic disturbances". The physical location of the disturbance will depend on the form of existence whose outlet has been blocked.

When the author deals with the various kinds of psychosomatic disorder and with the practical problems presented by his patients, the cryptic significance of this philosophical existence is transformed into more familiar meanings. Philosophizing then gives way to ingenious reasoning by analogy.

Here are some examples.

In 40 cases of anorexia nervosa the patients were found to "consume themselves" because their existence had become intolerable.

After the German occupation of France in 1940 the existence of French people was suddenly and violently altered and hemmed in. This existence (in its philosophical sense) was thus forced back into the medium of the body, causing obesity in many young people in spite of insufficient food.

Accident-proneness occurs in people who live in a social environment of great stress. They cannot break away, they break a bone instead.

"Decisive for the onset of essential hypertension is existence under excessive tension and pressure." However, many patients are not aware of this, and show no outward signs of tension and pressure either. It may require months or years of psychoanalysis to uncover this fact. Statistical studies by means of questionnaires are therefore quite useless.

"The asthmatic spasm of bronchial muscles, this organ-neurotic choking and checking of respiration, has to be interpreted as the physical manifestation of an existence that is stiff with the dread of a world full of unbearable irritation." This will happen whenever the asthmatic feels deprived of motherly protection.

The function of the upper alimentary tract is to grab, manage, and acquire things of the world. That form of existence that deals with things of the world in the same manner may therefore give rise to psychosomatic disorders of the upper alimentary tract, if it cannot find an adequate outlet, or is excessively used to the exclusion of other existential possibilities. The latter explanation was found to hold good in peptic ulcer patients. "The existence of all (*sic*) ulcer patients who have been adequately examined so far, is almost exclusively focused on grabbing, managing, and acquiring the things of the world." In contrast to psychoanalytical writers it is stressed that such ambitious and

greedy attitudes do not always originate in infancy; conditions of later life may have a similar, though less damaging, effect.

At the end of the book one is left wondering about the value of these existentialist flights of speculation. To the science of medicine they contribute obviously nothing. But what about the art of medicine? To some practioners of psychotherapy existentialist philosophy has an evident appeal. In dealing with the problems of their patients they may derive some help from it. At a time when psychoanalytic thought overemphazises the importance of events in early childhood, existentialist thought may serve as a corrective by stressing the significance of inadequacies in the patient's present life situation. Psychotherapeutic resources, as this book amply demonstrates, may have to range from long-term psychoanalysis to active interference with an abnormal or stunted way of living.

F. KRÄUPL TAYLOR

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Journal of Psychosomatic Research ,1956 ,Vol. 1, pp. 233 to 246. Pergamon Press Ltd., London

EXPERIMENTS UPON THE TOTAL INHIBITION OF STAMMERING BY EXTERNAL CONTROL, AND SOME CLINICAL RESULTS

COLIN CHERRY, D.Sc. and BRUCE MCA. SAYERS, M.Sc.*

Clinical Notes in Appendix by PAULINE M. MARLAND†

1. SYNTHETICALLY PRODUCED "STAMMERING"

THE method by which people of normal speech habits may have their speech-behaviour seriously disturbed was reported some years ago by LEE (1950). These results are now well known and have been widely demonstrated. The method, usually known as delayed-playback speech, consists of recording a speaker's speech on a magnetic-tape machine and playing this record back to him whilst he is speaking, through well-fitting headphones, but delayed by approximately 1/10–1/5 second. As a result the subject hears his own speech in an unnatural time relationship with his voice production; his perceptual habits and self-monitoring of speech are disturbed, the consequence being an excessive drawling of vowels, repetition of words, stuttering of syllables, and other defects. We are not here intending to suggest that true stammering behaviour is an analogous phenomenon, but rather to assume the moral that the production of speech involves a closed-cycle feedback action, by which means a speaker continually monitors and checks his own voice production.

We are extending this hypothesis, and suggesting that stammering (functionally) represents a type of relaxation oscillation, caused by instability of the feedback loop. This is a hypothesis, but with no pretence to formal theory; to check it, various experiments have been designed to break the closed-cycle feedback loop, by interfering with a speaker's perceptions, using individuals having chronic stammering habits. The results have been surprising, both as regards their universality over a very wide range of cases, and as regards their extent; the stammering habits can be almost totally inhibited and normal speech induced, suggesting that the determining defects are perceptual rather than motor.

The suggestion that speech and aural perception are closely integrated into a self-monitoring feedback activity is by no means new. SIKORSKI called attention to the importance of "self-awareness" in speech behaviour as early as 1892, and FREUND (1932) emphasized that many psychic phenomena suggest the wide use of feedback reinforcement. KERN (1932) stressed the need for examining the feedback actions provided by auditory perception, and their significance to the phenomenon of stammering. He writes: "The last ten years have seen studies concentrated on motor behaviour . . . effort should perhaps now be focused on taking away the *attention* from the vocal actions." He proceeds to describe what happens when stammerers read from books, whilst they are partially deafened by the sound of a Barany drum.

The experiments described here, carried out in collaboration with Mrs. P. M. MARLAND, are closely related to this earlier work by KERN; we would appear to

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have rediscovered his main findings independently but, as might be expected from the use of more modern techniques, to have made these findings much more precise and consistent, and in a very enhanced form.*

There are two ways in which the self-monitoring (feedback) actions due to auditory perception may be prevented, in order that their effects upon speech behaviour may be observed:

(a) By deafening—suppressing both air and bone-conducted hearing, in ways more extreme than that used by KERN.

(b) By compelling transference of the speaker's perceptions to a source of sound other than his own speech.

It is this latter means which provided our own approach to the phenomenon of stammering, though we have been led to conclusions wholly in agreement with those of KERN. However, this diametrically opposite approach may itself be not without value; for whilst we are inclined to agree with KERN that the inhibition of stammering by temporary deafening may have no therapeutic value (and may even involve risk) we would suggest, tentatively and cautiously, that inhibition of stammering by transference of the auditory perceptions may provide valuable means for the clinical treatment of stammerers.

2. THE NATURAL READINESS FOR IMITATIVE ACTION—THE SPEECH-SHADOWING TECHNIQUE

The starting-point of our experiments is the technique we have termed shadowing, a means for compelling at least a partial transference of a speaker's auditory perceptions away from his own voice to that of another speaker, as reported earlier by one of the writers (CHERRY, 1953). This concerned the great ease with which we can speak at the same time as someone else, if we copy what they are saying. One speaker (the *control*) reads from a book, and a second (the *subject*) shadows him without seeing the text. The subject may have only a vague idea of the content of the words he utters, perhaps none if the text is difficult. This shadowing is an imitative motor action accomplished with surprising ease; the subject's perceptions are transferred, to a large extent, away from his own voice, to the control speaker's voice. It is as though the subject's deeply engrained speech habits are readily stimulated into action, by his perceptions of sounds conforming fairly closely to these habits. Using an English control speaker and an American subject, it has been found that the latter lapses into common Americanisms (like *gotten*, rail-*road*, etc.), these being his own speech habits.

It is this speech-shadowing technique which has been put to clinical use, with most encouraging results; a short report is appended.

(a) *Intention movements*; *imitative behaviour*

This readiness for shadowing, or imitative speech behaviour, may perhaps be allied to the so called *intention movements* of animals (as in flocking, or swarming, where one creature is stimulated into imitating the behaviour of others in a group). There are other similar infectious actions in humans—as yawning, or giggling—and there are certain, almost unavoidable, imitative actions which are very common—such as marching in step, or in time to a tune, or singing in a choir (in true, or imagined, tune). There are endless examples, and we suggest that speech may be a kind of activity which is in a closely related class, but no more.

* We are indebted to Dr. EMIL FROESCHELS for calling our attention to this earlier work.

The question then arises: in view of the naturalness and readiness of such speech shadowing, might we not expect stammerers to show similar behaviour? During our experiments a number of subjects reported that they had no difficulty in singing in a choir, or in reciting the Lord's prayer in church, in unison. This is not quite identical with shadowing, because the utterances are learned beforehand and so provide a lessened stimulus; such actions merely emphasize their readiness for imitation, no more.

Numerous "speech shadowing" tests have been carried out, with a variety of adult stammerers as subjects, and they have shown an ability to speak coherently, with little or no difference from normal people. It was decided to investigate this technique further, for although different people experience varying difficulties at first, they all show improvement with practice; that is, speech shadowing seems to represent a marked learning situation.

(b) *Simultaneous reading*

A somewhat similar external control is provided by simultaneous reading; in this, the subject and the control read together from the same seen text. It has been found that stammerers, of all the types studied, and unable to read alone could do this almost immediately with no more than a few seconds practice. Again, such a technique has the effect of partially transferring the subject's perceptions away from his own speech-sounds to those of the control.

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It might be objected here, that the results of such highly personal experiments would depend upon other factors in the sufferer's environment, or upon his emotional state. But it has been found that both the shadowing and the simultaneous reading techniques were always successful with a very wide sample of sufferers, under varied conditions and on a number of different occasions. There were no negative results. For example, the experiments were carried out with one sympathetic person watching, with a few sympathetic persons, and with a dozen strangers. The stammering subjects came from many walks of life, and they had very different histories, educations, and personal environments.

The simultaneous reading technique has led to a number of secondary but important observations. The first was the distinction between the success of control in the steady-state condition, when the subject had settled down to fluent utterance and was steadily following the control speaker, and that in the initial launching or starting condition. In this latter, it was found that some stammerers have difficulty in commencing utterance, when the control speaker first starts reading the text. Consequently, further investigation into the distinction between the steady-state and the starting conditions was required.

(c) *Control by independent vocal stimuli*

(i) *Using different texts.* A second observation has more profound implications. We found that during the simultaneous reading tests the control speaker could switch his reading to another paragraph, without warning, whilst the subject continued to read without stammering through the original paragraph. We then had the spectacle of the two people reading different material simultaneously, with the implication that it is not the words, their interpretation, or their semantic content, which exercises control over the stammerer; rather, it is the physical sounds of the control speaker's voice which are significant, or some elements of these sounds. Further investigation has been made to determine what elements of voice-sounds are of importance.

(ii) *Using gibberish.* The conclusion is further strengthened by another test, in which the control speaker commences by reading from a text, with the subject reading simultaneously and with no stammering; later, the control speaker changes without warning to speaking complete gibberish. It is extremely easy, with a little self-training, to mouth gibberish-sounds without using any true words of one's language; nevertheless, the sounds uttered will undoubtedly conform to the *phonetic* structure of the language, through the constraints operating by virtue of deeply engrained speech habits. Such gibberish is essentially speech-like.

Again, under such control (and steady-state) conditions, stammering was completely inhibited in all cases, on all occasions.

(iii) *Using reversed speech.* Another form of control, giving similar results and illustrating similar points, arose from playing a vocal recording backwards, through headphones, to the subject (reversed speech). What, then, are the acoustic elements of the phonetic sounds which exercise such strong influence over the subject's perceptions?

The various experiments described above have all employed vocal stimuli, to place inhibitory control upon a stammerer's voice, resulting in nearly normal speech behaviour. The qualification "nearly" is stressed. For the results of such methods of control, using external speech or speech-like stimuli, have not been absolutely certain and regular; there has been some degree of variation between the various subjects used depending, *inter alia*, upon the difficulty of the text used for the shadowing tests and upon the extent of the stammerer's experience with the technique. Some stammerers can shadow immediately, at first trial; others work up to fluency more or less quickly. Indeed, it is this very personal variation, with the suggestion that learning is taking place, which underlines the therapeutic possibilities of the shadowing technique. As a technique it is fairly naturalistic, having relation to the normal processes of learning to speak and hear during infancy. The hope is that with continued shadowing exercises, using suitable texts, a sufferer's perceptual habits might be changed; this is being borne out well by the first clinical experiments, as reported in the Appendix.

These first experiments used speech and speech-like stimuli and, as already mentioned, carried the implication that it is purely acoustic elements which exercise control over the attention, rather than interpretation or meaning. But in real life, when one is speaking, the speech is controlled by feedback mediated through both air-conduction and bone-conduction pathways. Is there any significant difference then, to a stammerer, between perceiving the purely air-conducted sounds of the control speaker's voice while shadowing and perceiving his own voice sounds through both pathways when he speaks alone?

The air-conduction and bone-conduction pathways differ very much in their acoustic properties. In order to investigate more closely the nature of the sounds which exercise control, some further experiments were made using, not speech stimuli, but instrumental means.

4. STAMMERING AS A PERCEPTUAL DEFECT

(a) *External control of perception*

Our previous results have given indications that control of the acoustic environment of speech and speech-like sounds perceived by the subject may provide at least a partial control of his speech difficulty. It is clearly important to determine what

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components the subject perceives out of his own voice whilst self-monitoring, and to determine which of the components of the speech stimulus take control in the perceptual habits which appear to give rise to stammering. That is, we should not assume that all components of the speech sounds exercise such controlling influence. The fact that a normal individual hears and monitors his own voice through both air conduction and bone conduction is widely realized. Subjectively these two stimuli are comparable in loudness. We set out to separate these two stimuli by interfering with the feedback channels which transmit them to the ears.

(b) *Separation of air-conduction and bone-conduction pathways*

Elimination of air-conducted sound alone is readily achieved by blocking the ears. The results with this method of interference were neither striking nor consistent. Elimination of both air and bone conducted voice sounds was effected by playing a loud masking tone into both ears of the subject through headphones. The loudness of the tone used approached pain level and complete masking of the subject's awareness of his own speech sound was achieved. The results of this experiment were immediate and consistent. Control of both steady-state speech and of the ability to make immediate starts in speaking was rapidly established. In general, virtually complete elimination of stammering resulted during the experiment. The ability of each subject to make an immediate start in speaking improved to a very considerable extent.

Thus we have found that elimination of air-conducted feedback of the monitored sounds has little effect on the performance of a stammering subject, whereas blocking both air-conduction and bone-conduction pathways of speech feedback results generally in a virtually complete suppression of stammering. Such a method of interference with the appropriate feedback pathways results in virtually complete control of both steady-state and starting-condition utterance of the stammerers we have studied.

(c) *The importance of the pitch of the perceived, monitored sounds*

The exact pitch of the masking tone is not critical within the approximate range: 120–180 cps. However, more detailed inspection has shown that it is essential to mask the *very-low*-frequency tones of the stammerer's voice, if he is to be controlled. A more elaborate masking technique is reported later, which demonstrates that if he hears the very lowest tones of his own voice, stammering will remain. No conjecture will be made here as to the physiological significance of these results. Clearly, a general difference in pitch of sounds transmitted by bone-conduction and by air-conduction pathways can be admitted (as can be demonstrated subjectively by listening to the difference in quality of one's own speech sounds, first while speaking, and second when hearing a high-quality gramophone or tape recording of the same utterances). It is well understood that bone-conducted sounds manifest a strong low-frequency emphasis which is not evident for air conducted sounds (BÉKÉSY and ROSENBLITH, 1951).

On the basis of the results we cannot verify whether perception of bone-conducted sounds alone is significant in stammering, or whether any feedback, whatever the channel, is adequate to set up the perceptual difficulty. But there is fortunately one clue to this problem in another connection. We have observed that in the case of

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artificially induced "stammering" in normal individuals (Section 1) using delayed playback speech, an interesting feature arises. The effect of sounds impressed on the ear through a bone conduction channel is considerably more severe than that of a correspondingly loud sound impressed through telephones by air conduction. (A simple bone-conduction channel is provided by an adapted electrical headphone pressed on the subject's temples.) The experience of such a bone-conducted "delayed playback" speech can be described as more than irritating; it can be quite distressing.

Finally we have attempted to assess the significance of the bone conduction pathway in another way. We have required the subjects to read a standard text, without voicing (i.e. in a whisper). Despite the extraordinary fact that few of our subjects seem to have had occasion to whisper and that indeed by no means all could be induced to do so, we have obtained some results.

Of 15 cases who were able to whisper only 3 showed any significant tendency to stammer whilst doing so. In 12 cases of the 15, the total breakdown duration averaged 3 seconds during the whispered reading of a 120-word text; the maximum observed was 5 seconds. In normal voiced reading, the total breakdown duration for these cases averaged 24 seconds, the maximum being 59 seconds. In one of the 3 exceptions the total breakdown interval during usual (voicing) performance was 15 seconds, reducing to 9 seconds whilst whispering. In another of the exceptions, the subject repeatedly broke into voicing but achieved a total breakdown duration of 32 seconds compared with 200 seconds for that during usual speaking (voicing) performance. In the other case no improvement was observed during whispering compared with the usual performance of relatively mild speech difficulty (total breakdown time 14 seconds).

It is evident that in some cases the elimination of bone-conducted sounds by whispering in this way is also highly rewarding in control of stammering. It seems likely therefore that the low-pitched components of the speech (monitored through a bone-conduction pathway) are of primary significance in mediating the perceptual abnormality which we associate with stammering. It remains to consider the stimuli preferentially transmitted by this pathway. The most important of such stimuli are undoubtedly the larynx tones of the speaker. Hence we are tentatively associating stammering with an abnormality in perception of the low frequency components of the larynx tones of the stammerer. This, of course, is not the same thing as saying that such an abnormality is a *cause*.

5. STATISTICAL RESULTS

It is proposed to report here the details of our experiments using stammerers, under the influence of acoustic masking, and also with the technique of speech shadowing.

A series of 54 cases has now been studied. In conformity with current English usage of the term "stammering," we have not attempted to subdivide or otherwise classify the cases we have seen. It is believed that to say this is to imply that each case is different. Our cases demonstrated a range of speech defects; namely, repetition of sounds, words or phrases, and hesitations and pauses of duration varying from $\frac{1}{2}$ sec up to severe blockages of some 30–60 seconds. In each case pauses and repetitions were accompanied by evidence of psychological tension such as facial grimacing, shuffling of the feet, and often temporary interference with respiration. For a test,

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each subject was given a standard text of 120 words to read aloud. The textual material was taken from contemporary nonfiction magazine articles. The time taken to read the text, the number of repetitions, hesitations, and breakdowns, and the duration of each breakdown were assessed. Using a new text, we determined the ability of each subject to make immediate starts in utterance when new parts of the text were pointed out, in quick succession.

The experiment was then repeated in entirety, using new textual material, whilst the subject was wearing a pair of neatly fitting telephones activated by high-energy 140-cps tone. Complete masking of the subject's aural awareness of his own voice was achieved by using a masking-tone loudness close to the threshold of pain. The whole experiment was then repeated.

The results are summarized in the figures. Fig. 1(A) shows the usual performance of each stammerer measured by average results before and after the masking experiment; Fig. 1(B) shows the performance under the influence of the masking tone. The parameter recorded is the total duration due to hesitations, blockages and repetitions

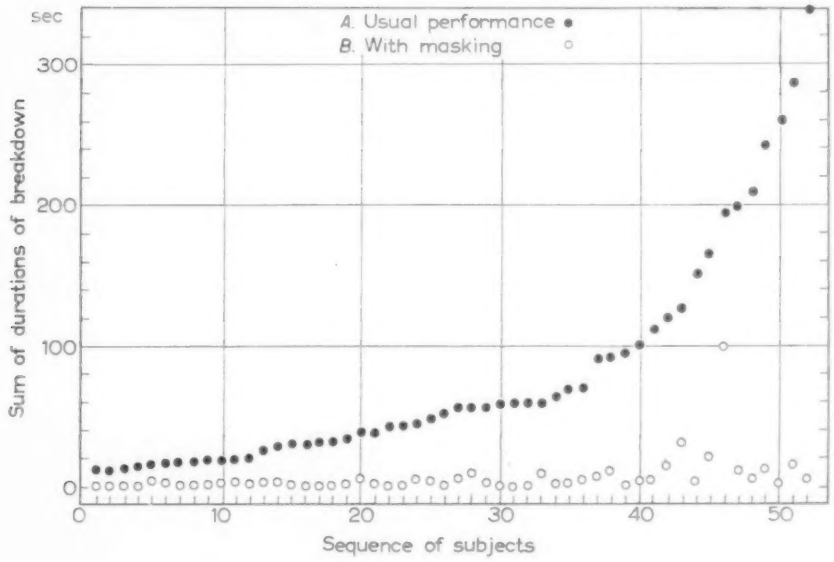

FIG. 1(A) (B)

while reading the standard text. (The time to read the text by a number of normal (nonstammering) individuals averaged 58 seconds.) The average duration of breakdowns, in the case of stammerers unassisted by masking, averaged 55 seconds.

The improvement observed in ability to make immediate starts in utterance is illustrated in a different way in Fig. 2, which gives the frequency distribution of cases showing given percentages of immediate, unhesitant starts. The improvement is again clearly demonstrated.

Another observation of interest concerns the temporal distribution of breakdown, both in the usual performance of stammerers and in the case of their tonally masked performance (to the small degree in which breakdowns remain). Discounting the one

exception to the general result we have described above, a rough estimate of the distribution in both situations can be made. This indicates that 90% of all (the relatively few) breakdowns under masking occur within the first five or six seconds. Under conditions of usual (nonmasked) performance, only some 10% of the much greater number of breakdowns occur within the same period. It is clear that control of both starting and steady-state conditions has been established, if not immediately, then within the first few seconds.

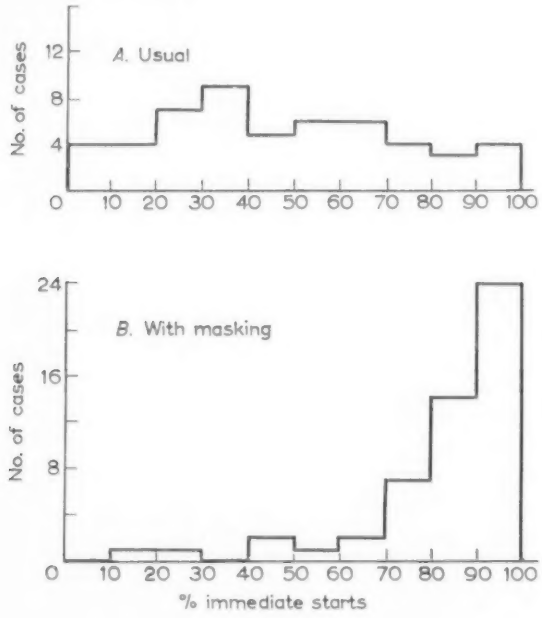

FIG. 2

We have measured also the ability of the subjects to shadow, concurrently and continuously, a message read aloud by a control speaker. In 39 cases of the 51 with whom we have tried this test, the stammerer was able to shadow a 120 word message, read by a tutor at the rate of 50–100 words per minute, with relatively few breakdowns, and without missing more than 5 words. In these cases the total duration of breakdowns for the worst case, whilst shadowing, was 4 seconds. In a further 8 cases of the 51, breakdowns of up to 15 seconds caused several phrases (6–20 words) to be missed. In the remaining 4 cases of the 51, the stammerer demonstrated an inferior ability in shadowing, and was unable to complete the message successfully. Thus in at least 75% of the stammerers we have seen, relatively little difficulty was experienced by subjects in carrying out this shadowing technique, particularly when the subjects were reassured before the attempt.

It should be emphasized that these results were obtained at virtually the first trial of the experiment in each case, with only elementary instructions and without any previous learning. Later investigation has led us to observe that this technique appears to establish what might be called a marked learning situation. People seemed to improve with practice. This improvement appeared to be maintained to various

degrees, so much so that it seemed essential to suggest clinical trial. A very preliminary account of some early clinical trials is reported in the appendix. In view of the known fact that stammering appears to be habit forming, it seemed possible that normal speaking also might be habit forming for a stammerer. We consider therefore that this last technique offers some possibility of treating stammering by controlling acoustic environment and training a sufferer in new habits of perception—namely those associated with normal patterns of speaking.

6. SOME ALTERNATIVE HYPOTHESES

Three main alternative hypotheses could perhaps be postulated to explain the results we have observed.

First, it might be argued that what we have found are distraction techniques for the inhibition of stammering behaviour. We would not deny this but would emphasize the generality, reproducibility and completeness of results from the particular techniques we use. Thus the shadowing technique, by its very nature, compels the stammerer to listen to the control speaker; whilst under the influence of this control, transference of at least part of his aural perceptions is ensured. Many other distraction techniques, (e.g. rhythmic movement of the arms) might also exercise such control, but the present techniques appear (from their very generality) to mediate control of a primary quality. Secondly, it may be suggested that the apparent environmental isolation produced by the use of a loud masking noise, might induce an improvement in a stammerer's speech habits just because a new situation has been created, and because the stammerer has the impression of isolation. The features of our experiments relevant to the previous hypothesis are also relevant to this. Furthermore we find no evidence that familiarity with the changed subjective situation causes a deterioration of the stammerer's speech behaviour while reading aloud.

These two hypotheses are expressed in subjective psychological terms; words such as distraction, attention, isolation, are used. But it is rather the experimental conditions and the resulting overt behaviour changes which we wish to emphasize in our own statement, in objective terms—not their correlates in sensations.

Thirdly, it is known that some stammerers show improved performance under normal conditions when speaking very loudly. Since the masking technique induced some subjects to speak loudly, might this not be a significant factor in the improvement which has been observed? Each of the last 30 subjects in our series was instructed, for reasons which were not explained to them, to speak very quietly for a 30-second period while the masking tone was applied. We have found no deterioration of the subject's performance, whilst reading, due to quiet speaking (at or below normal levels) in any case. Under the influence of the masking noise, some subjects spontaneously spoke at normal or less than normal levels. It is therefore evident that the loudness of speaking was not a significant factor in these experiments.

7. PARTIAL PERCEPTION; EFFECTS UPON STAMMERERS OF HEARING LOW-PITCH VOICE TONES

The masking tone used in the experiments so far described resulted from sinusoidal excitation of a pair of headphones, at about 140 cycles per second; the sound waves produced are such as to set the basilar membrane into vibration and so to obliterate all hearing, over the whole range of pitch of the human voice. We considered it of

interest to observe what happens if the sound is changed in character in such a way as to permit the listener to hear only the very-low-frequency sounds of his voice. That is, how low in pitch must the obliteration extend, for control of stammering?

Rather than use a pure-tone masking sound (with its highly concentrated energy), we have chosen to work with a white-noise masking sound,* which has its energy widely spread over the whole aural spectrum; then this sound is passed through one of two filters which effectively concentrate the energy into frequency components lying: (a) below about 500 cycles per second or (b) above about 500 cycles per second.

The first of these filtered white noises (low frequency) is far more pleasant to listen to than a loud low-frequency pure tone, but is as effective in obliterating hearing of low-frequency sounds; such a masking sound has been found to be equally effective in inhibiting stammering behaviour. The results are again consistent and virtually complete.

The second of these filtered white noises (high-frequency) obliterates all hearing except that of the extreme-low-frequency voice sounds. The listener then has some awareness of these components of his own voice. The results of such tests have been interesting and, we believe, significant, because they have been found to be very varied indeed compared with the results obtained with the low-frequency masking noise. Fourteen cases were examined for this comparison; details are given in Table 1.

TABLE 1.—THE EFFECTS OF FILTERED-WHITE-NOISE MASKING UPON STAMMERING BEHAVIOUR
(Total breakdown time during reading of a 120-word text)

Case	(a) *Noise through Low-pass Filter.* Breakdown duration (seconds)		% *Reduction*	(b) *Noise through High-pass Filter.* Breakdown duration (seconds)		% *Reduction*
	Usual	*Masked*		*Usual*	*Masked*	
a.	260	2	100	220	150	32
b.	200	10	95	180	25	86
c.	150	10	93	162	110	32
d.	125	15	88	105	82	22
e.	93	11	88	80	30	63
f.	90	7	92	81	10	88
g.	56	3	95	70	75	−7
h.	48	4	90	44	64	−45
i.	44	1	98	31	15	52
j.	38	5	87	43	25	42
k.	31	0	100	24	4	83
l.	22	1	95	22	18	18
m.	19	0	100	26	22	15
n.	18	0	100	15	14	6

Average reduction with low-frequency-noise masking = 94 ± 5%
" " " high- " " " = 35 ± 37%
The *t*-test on the difference in means of the two samples shows that the difference is very significant, i.e. at the p = 0.1% level ($t = 6{,}0$; d.f. = 26).

* White noise is the technical term for a sound which has its frequency energy uniformly spread over all frequencies. It can very readily be generated electronically.

From these figures we make two observations: (1) Under the condition of high-frequency-noise masking (when the subject is aware of his low-frequency voice tones) stammering is by no means generally suppressed, and may even be made worse. Consequently we conclude that total masking of the extreme-low-frequency sounds of his voice is essential in such experiments for the control of a stammerer's speech. (2) We notice the very great variability of behaviour, when using high-frequency-noise masking. This scatter seems to us to be of significance. Thus, on our hypothesis that stammering is mediated by (note: not *caused* by) the subject's perceptions of his own low-frequency voice sounds, one cannot set a universal threshold on the frequency of instability, that is upon a threshold of frequency below which a speaker's perceptions of his own voice should not pass. Rather, the safe threshold would seem to vary from individual to individual; then his potential for stammering behaviour is a function of the extent to which his aural perceptions are allowed to exceed his particular threshold by the conditions of his environment.

SUMMARY

A series of experiments is described, carried out on 54 widely varied adult patients suffering from forms of chronic stammering. Different external acoustic stimuli were used, which resulted generally in almost total inhibition of stammering behaviour. This demonstrates that, in all these varied cases, stammering is a perceptual rather than a motor abnormality. Under control, the sufferers were induced to speak and read at normal rates.

An interesting feature of these results is their universal nature, since the cases were drawn from a wide field. Some of the experiments have suggested methods for training, and show some therapeutic promise.

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APPENDIX

Notes on some preliminary clinical trials

The object of these first trials has been to determine whether our findings may have any clinical value, and to gather experience of various methods of organizing and executing the shadowing technique, in children and adults. Briefly, the aim has been to train the stammerers into new habits of aural perception.

For very young children two types of recordings of simple stories were made. In the first, pauses occurred after each phrase; in the second no pauses occurred. The first record was played and the child asked to repeat each phrase aloud, during the subsequent interval (copying). The second record was then played, after it had been explained to the child that he should continue talking, since no pauses would occur (shadowing). Whilst young children appear to be able to carry out the first task, with the help of some unison speaking, more practice seems to be required before they can shadow really adequately. Disc records were given to them for daily home practice; later, stories were read to them by their parents for shadowing, though this was avoided when the parents were of nervous temperament.

With older school children, shadowing was understood at once, though their early performances suffered due to losing the (spoken) place, and to missing phrases. The use of headphones for relaying either disc-recorded speech, or the voice of the therapist reading into a microphone, has proved useful in teaching shadowing. Instructing the patient to face away from the therapist has also been found helpful. In several cases the voice was initially very monotonous, with the speech jerky and arhythmic; there were some stammering breakdowns, mainly on unfamiliar or misheard words, or, if the subject was conscious of his accent, on words which he usually pronounced differently. Breakdowns soon became less frequent, but the defects in rhythm took longer to correct. One common fault was as follows; the child paused to listen, and followed this by a rush of words to catch up, when the end of the phrase had been heard. As the quality and the speed of shadowing improved, so did the quality of conversational speech. In those who found difficulty in shadowing, practice of two-text reading

(in which the therapist reads one text and the stammerer another) led to an improvement in shadowing. It is well known that stammering can build up rapidly when confidence is lost, whether in conversation or reading, and in a few cases this has also applied in shadowing. In all these situations when patients found themselves unable to complete a particular phrase, several repetitions of this phrase by the therapist, with out-of-phase shadowing by the stammerer, has been found useful in helping them to pick up normal rhythm again. (This is no doubt related psychologically to the "cancelling out of blocks", VAN RIPER, 1954.) As soon as the patient had acquired the normal rhythm of the phrase in question, the therapist stopped repeating it and either continued reading (in shadowing) or left him to continue (in conversation and solo reading). Some individuals who found difficulty in shadowing showed an improvement in this ability when merely reminded "to attend to the rhythm".

Practice in shadowing appeared to lose efficacy when the textual passage used had been memorized by frequent repetition (as with gramophone records). It seemed necessary to use very simple texts at the start, and to read them in a smooth manner, although only *normal* rhythm and intonation were used throughout. Some cases showed a strong tendency to try to speak in unison at first. Whispering was used with other cases who were unable to shadow voiced speech at the start.

With adults, observations were similar to those with older school children. In severe cases, they were often initially unable to copy phrase by phrase (in contrast to very young children) but learned to shadow fairly easily and at gradually increasing speed. Once able to shadow, they learned copying much more easily. One or two adults and older chidren with very severe stammering were able to shadow rapid speech only. In this type of shadowing the individual automatically falls much further behind, and hears whole phrases before beginning to shadow them. These patients derived benefit from being taught to shadow slow speech.

At whatever point on the scale a stammerer began, the aim was to lead him up through these forms of training, gradually increasing the difficulty of the task until he was able to retain stable rhythm in conversation without any aids, and to maintain a high threshold of tolerance to environmental stimulation.

Psychological considerations have not been overlooked, and it is not suggested that methods of retraining aural perception would be sufficient without any psychological help except in certain cases, but that these methods may prove to be a useful contribution to the treatment of stammering.

No general conclusions can be reached from the few cases summarized below; they illustrate the technique with which experiments have been started, the types of case, and the time intervals involved.

Case No. 1. A boy aged two and a half years had stammered for 4 months before treatment by standard methods was given (advice to parents). The difficulty then disappeared for 9 months but recurred in a more severe form on his entering nursery school. After 8 months, (at age 4 years) shadowing practice was instituted as a form of play. The child apparently did not connect this with his stammer. After daily practice for 10 days the stammer disappeared and has not recurred during the following 5 months, including the upheaval of family migration to another country. At such times of strain the mother resorted to daily shadowing practice with the child again.

A school report stated that a year ago the child "was stammering so badly we were hardly able to understand him. His speech is now perfectly normal."

Case No. 2. A girl, aged 6 years, while being treated for an articulation defect, developed a stammer which became extremely severe. A number of forms of treatment for the stammer proved valueless. Practice with copying and shadowing was then started, and improvement was noticed within a week. Of the two, she strongly preferred copying, probably because of the immaturity of her speech generally. After several weeks practice the stammer had disappeared except for very occasional lengthened vowel sounds. Treatment of the articulation defect was then resumed and had no deleterious effect on fluency. The child was discharged (for follow-up) with only occasional vowel prolongations. and articulation within normal limits for her age.

Case No. 3. A schoolboy, aged 16 years, had a very severe stammer, with word-blockages of up to three and a half minutes duration. Standard methods of treatment over a period of five months resulted in slight temporary improvements. At the end of this time he was in a bad phase; long blocks with violent grimacing virtually prohibited conversation. Shadowing practice was then started and resulted in immediate improvement. The boy continued it alone using gramophone records at home, daily for 5 months, with weekly visits to the therapist for correction of his current faults in technique. Subsequently, practice once every two to three days was found adequate. His speech was then nearly normal, and he was able to make telephone calls, entertain his parents' friends, and speak freely in

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class. Except for three brief very mild set-backs (of which the cause was unknown) the improvement has been steady and maintained over a period of a year. In a professional interview 3 months ago the boy did not stammer and only slightly abnormal rhythm was evident.

Case No. 4. A boy, 6 years old, was treated in 1954 over several months for his stammer. Standard methods of treatment produced a gradual improvement. In 1955 the child had a recurrence of the stammer in a severe form. Standard methods of treatment were not successful. Shadowing was then taught and practiced daily. The child showed strain in the form of wriggling, kicking, frowning, and jerky speech while shadowing for the first 3 weeks, but he then mastered the technique (at his third treatment) and the stammer had disappeared one week later, except for a very infrequent momentary catch in his breathing. In the next 5 months the improvement has been maintained except for a single brief setback from which the boy recovered quickly after resuming home practice of shadowing for a few days.

Case No. 5. A Singhalese student, aged 20, had jerky speech and a "gulping" type of stammer with grimacing. After daily shadowing practice for 6 weeks, his speech became smooth and of virtually normal rhythm and the grimacing had disappeared. The stammer occurred occasionally in a very much milder form.

Case No. 6. A man of 59 years, with a violently explosive stammer of 51 years' duration, had made unsuccessful attempts to improve his speech (by various methods) since 1920. In shadowing practice he was at first only able to follow rapid speech. For a time he practised only occasionally, but when daily practice of slow shadowing was employed his speech improvement accelerated.

While he has still a comparatively severe stammer, it is very much less explosive and, measured by the methods used in the present paper, had been reduced by some 60–66% in four months, and is still improving.

Case No. 7. A man of 39 had a very severe, constant, violently explosive stammer of tono-clonic type, of 34 years' duration. During speaking, showers of saliva were produced. The stammer had improved several years ago but recurred after a family bereavement. After explanation and brief practice this man was able to shadow very slow reading at his first treatment. No helper was available for practice at home, and the slowest disc-recorded speech available (for a heavy-weight pick-up) was still too fast for him until he was familiar with the content. In spite of these handicaps, striking improvement was observed after 4 visits (treatment once weekly).

In general, after two months, this man's speech is now slower, much freer, with much less tension and no spitting; he already reports the ability to make long phone calls without noticeable difficulty. He is occasionally disturbed by stammering spasms which are habit-forming in one conversation if not taken in hand. This may be done by directing attention to the correct rhythm of an incorrectly spoken sentence. If this fails, an immediate improvement in his conversational speech follows a period of shadowing.

Case No. 8. A girl of 17, in whose family most of the females have stammered for several generations, has an inspiratory stammer mainly on voiceless consonants. She has improved with daily shadowing practice but only very slowly as compared with the previous cases. She still stammers while shadowing; does so less if using headphones.

Case No. 9. A boy of 12 has stammered for seven years, particularly on voiceless consonants. A psychiatrist had pronounced him normal except that he was over-emotional when frustrated. He was unusual in that he stammered most on totally unimportant sentences. All forms of speech therapy tried had failed, and any discussion of his speech caused his eyes to fill with tears. This occurred if he blocked badly in shadowing. Although this boy did learn to shadow well there was no noticeable improvement in his daily speech.

Case No. 10. A boy of 16 with the most severe form of stammering, complete freezing into immobility on attempting to speak, said that his stammer had taken that form since it began at the age of 7. He was unable even to make single consonant sounds on request. The attempt to teach shadowing produced further anxiety and was abandoned.

The use of brief periods of filtered white noise (low frequencies) played through headphones under strict supervision, is now being tried clinically for conversational speech as well as reading, in school children and adults. Some school children react unfavourably by flushing of the face and increased stammering, in spite of being forewarned. One child asked for a second trial and was then no longer worried by it and showed some improvement in speech. Case No. 3 responds in a striking manner and experiences pleasure in the smooth conversational speech which he can produce under these

conditions. This is so also for Case No. 6, but at present his fluency in conversational speech masked by white noise deteriorates after about a minute and has to be brought out anew by starting again after a pause. Deterioration during a long conversation is one of the unvarying characteristics of his stammer under normal conditions.

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HOMOSEXUALITY AND CHROMOSOMAL SEX

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THIS paper describes an investigation to test the validity of LANG's theory for the aetiology of homosexuality (LANG, 1940). LANG suggested that some male homosexuals were " . . . . real male sex intergrades which are genetically female but have lost all morphological sex characteristics except their chromosome formula." The sex of a cell is governed by the balance between the autosomes and the *X* chromosomes; a relative excess of autosomes results in a male; an excess of *X* chromosomes, a female. Normally one *X* chromosome fails to outweigh the autosomes and the cell is male, two *X* chromosomes however result in a female. LANG suggested that homosexuality was due to an imbalance between autosomes and the feminizing *X* chromosomes and that some homosexuals were genotypical females although phenotypically males. To test this hypothesis he investigated the sex ratio of the siblings of 1015 male homosexuals. He found that the sex ratio of the siblings was altered significantly from the normal of 100 females to 105 males to one of 100 females to 121 males and that this was even more pronounced in the older and probably more genuine homosexuals. This is explicable in terms of LANG's theory by some of the "males" being genotypical females, thus accounting for the higher incidence of males among the siblings of homosexuals. The investigation was fully controlled by another large series of 1296 male probands, which showed a normal sex ratio among their siblings of 100 females to 107 males. LANG's work was confirmed by JENSCH in 2072 homosexual probands where the sibling sex ratio was 100 females to 115 males (JENSCH, 1941). KALLMANN (1952a, b) and DARKE (1948) in small numbers of about 100 cases, came to varying conclusions; KALLMANN agreed with the previous findings and DARKE opposed them. Obviously, if a phenotypically male homosexual is genotypically female, he could produce only female children when matched with a normal woman. It would therefore be far more valuable to demonstrate an abnormality in the sex ratio of the offspring of homosexuals and in LANG'S series this ratio was normal. However, as LANG points out, it may well be that a genotypically female but phenotypically male homosexual may be infertile.

LANG'S work was inspired by GOLDSCHMIDT'S experiments on the Gipsy-moth where he was able to produce all degrees of intersex by cross-breeding species from different geographical areas (GOLDSCHMIDT, 1931, 1938). STIGLER (1934) believed that intersexual conditions in man can be caused by the same mechanism. LANG demonstrated that the abnormal sex ratio was also present in the paternal half-siblings of homosexuals but not in the maternal half-siblings. For this reason WITSCHI and MENGERT (1942) considered that the abnormal sex ratio could be explained by the presence of a gene transmitted through the father and causing sex reversal. TSCHERMACK'S rather speculative theory explaining the normal sex ratio on the basis of subfactors strengthening the *XX* or *XY* disposition and allowing for

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intersex conditions could also account for LANG's findings (TSCHERMACK, 1939). Thus on the basis of all these theories, some homosexuals should have a typical set of female *XX* chromosomes.

The majority of clinicians, however, favour an environmental aetiology and recent evidence supporting such a view has come from studies on gonadal agenesis and pseudohermaphroditism. A series of such cases has recently been subjected to psychological investigation (HAMPSON, 1955; MONEY, 1955; MONEY *et al.*, 1955a, b). Many of these cases are reared as a male or female in contradiction to the chromosomal or gonadal sex, and in some cases in contradiction to the predominant characteristics of the external genitalia. MONEY and his colleagues found that the chromosomal sex of the patient was relatively unimportant in the development of erotic feeling in a particular direction; more important was the upbringing of the child and the child's own conception of its sex. Their view seems to be that once the genes have initiated the development of one or other of the primitive gonads, they play little part in differentiating the gender role of the child.

As SLATER wrote in commenting on a genetic aetiology of homosexuality, "A much more direct test . . . . would presumably be obtained by biopsy and cytological examination of the chromosomes" (SLATER, 1950). A technique which makes this possible has recently been developed.

A technique for chromosomal sexing of cells was first demonstrated by BARR and his colleagues in 1949 and has since been modified so that, in their own hands, cells from a simple mouth scraping revealed no error in sexing in a consecutive series of 140 cases (BARR and BERTRAM, 1949); MOORE and BARR, 1955). They describe a chromatin spot which differentiates a male from a female cell and which is thought to be composed of two *X* chromosomes fused together; a single *X* chromosome is insufficient by itself to be recognized under ordinary conditions and autosomes are so diffuse that it is almost impossible to identify them individually. This technique applies to the many different species of animals which they have studied, and also to the twenty different tissues and organs which they have examined in the human (MOORE *et al.*, 1953; MOORE and BARR, 1954). The technique has been used in assessing the sex in gonadal agenesis, pseudohermaphroditism, and KLINEFELTER'S syndrome and so far has proved entirely satisfactory (ARMSTRONG, 1955; GRUMBACH *et al.*, 1955a, b; WILKINS *et al.*, 1955; CARPENTIER *et al.*, 1956; RIIS *et al.*, 1956; SUN and RAKOFF, 1956).

The chromosome spot is found in the intermitotic state in about 75% of female cells according to MOORE and BARR (1954, 1955) but a similar type of spot also occurs in up to 20% of male cells. The fact that there is no overlap enables the distinction between male and female. EMERY and MCMILLAN (1954) carried out a differential count on 100 cells in a series of male and female subjects, and found that the incidence varied between 25% and 54% in female subjects. Although most males had an incidence of less than 4%, some had spots in up to 9% of cells. EMERY and MCMILLAN counted only those spots actually adhering to the nuclear membrane and disregarded those spots seen flat on the upper or under surface of the nucleus. The nature of the spots in the male cells has yet to be explained; often they are not typical of sex chromatin. The fact that the incidence of chromatin spots in females is not 100% is accounted for by the fact that many spots would be invisible because of the position of the cell.

METHOD OF PRESENT INVESTIGATION

50 male homosexuals who had attended the Maudsley hospital were seen and rated on KINSEY's 0–6 scale, where 0 indicates that the patient has never been erotically aroused by his own sex, 6 that he has never been erotically aroused by a female (KINSEY *et al.*, 1948). The average rating was 4·5, with a range from 1 to 6, the standard deviation being 1·49. The ages of the patients varied between 18 and 64 years with a mean of 35 years. The cells from the mouth scrapings of these 50 homosexuals and from 25 male and 25 female controls were stained with haematoxylin and eosin and examined for the presence of chromatin spots, using the criteria suggested by EMERY and MCMILLAN (1954). The slides were randomized so that the microscopist could not know whether the cells were from a homosexual or a control.

RESULTS

The results are shown in the accompanying table (Table 1).

(1) Controls. The incidence of chromatin spots corresponds very well with that reported by EMERY and MCMILLAN whose criteria were followed: chromatin spots were seen in 22–65% of cells in the females and in 0–6% of cells in the male controls. The wide disparity in the incidence of spots between male and female made absolute sexing easy.

(2) Male Homosexuals. (a) The chromosomal sex in all cases was male, (b) The incidence of chromosomal spots was similar to that in normal male controls: chromatin spots were seen in 0–8% of cells. The incidence of chromatin spots was influenced neither by age (comparing cases under 30 years with those 30 years or over), nor by their homosexual rating (comparing those with a rating of 4 or less with cases rated 5 or 6).

TABLE 1—SHOWING THE PERCENTAGE INCIDENCE OF CHROMATIN SPOTS IN THE CELLS FROM THE MOUTH SCRAPINGS OF 50 MALE HOMOSEXUALS AND FROM 25 MALE AND 25 FEMALE CONTROLS

	Female controls (25)	Male controls (25)	Male homosexuals (50)
Mean	45%	1·52%	1·50%
Range	22–65%	0–6%	0–8%
Standard Deviation	11·5	2·0	2·2

DISCUSSION

The fact that the 50 male homosexuals studied in the present investigation had a normal male chromosomal pattern is strong evidence against LANG's theory that many male homosexuals are female genotypes. However KALLMANN's work on homosexual twins suggests that a genetic factor is present (KALLMANN 1952a, b). Such a factor, which may have nothing to do with chromosomal reversal, could possibly be related to a predisposition towards male children, thus explaining LANG's finding of an abnormal sibling ratio in the families of homosexuals. MONEY and his colleagues have shown that environmental factors play a large part in the determination

of the sexual goal in an individual. Which of these two factors is the more important in homosexuality in the present social organization, remains an open question.

SUMMARY

(1) The mouth scrapings from 50 male homosexuals were chromosomally sexed and compared with the results obtained from similar studies in 25 male and 25 female controls.

(2) The chromosomal sex in the 50 homosexuals was male in all cases, nor did the incidence of chromatin spots differ from normal male controls.

(3) These results are strong evidence against LANG's theory that many male homosexuals are genotypically female, but by no means excludes a genetic aetiology for homosexuality.

Acknowledgements—I am grateful for the help given by Drs. ELIOT SLATER and DENIS LEIGH in carrying out this work. Mr. P. CHAPPELL gave technical advice and took the photographs.

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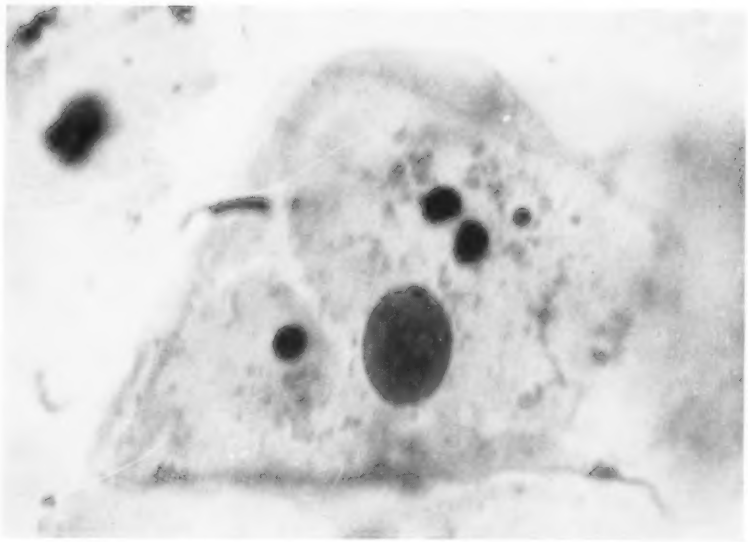

FIG. 1. Cells from the mouth scraping of a female control, showing the sex chromatin in its typical position at the periphery of the nucleus.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 252 to 257. Pergamon Press Ltd., London

COAGULATION TIME OF THE BLOOD, LEVEL OF BLOOD EOSINOPHILS AND THROMBOCYTES UNDER EMOTIONAL STRESS

F. DREYFUSS, M.D.*

THE following study of the coagulation time during and after an oral examination was undertaken with the intention of detecting whether, and to what extent, a state of accelerated coagulation existed under emotional stress in healthy individuals. The circumstances preceding and accompanying a final examination in medicine as a main subject of the curriculum are likely to produce a pattern of stress both prolonged and acute in nature: it affects the student, usually an otherwise healthy, young individual, acutely after a certain buildup of tension and mental effort. It represents, however, a situation devoid as a rule of major contributing physical or somatic-stress factors.

In a previous study of this and another anxiety-loaded situation—the pre-operative state—the frequent occurrence of a drop in the absolute eosinophil count of 42% on the average could be shown (DREYFUSS and FELDMAN, 1952); THORN and his co-workers (1951), in a set of circumstances involving physical as well as emotional stress (competitive boat-racing), obtained a similar figure, as well as HUMPHREYS and RAAB (1950) in medical students before and some time after their examinations. Recent studies have confirmed these previous observations (KERR, 1956; MARKHAM *et al.*, 1956). The recent observation of an attack of coronary thrombosis occurring during the examination in a student of another faculty further aroused our interest in this problem.

CANNON in 1914 reported rapid clotting of the blood in enraged cats. SCHNEIDER (1950) in a study of the reaction to stress showed that vigorous exercise, pain, as well as emotional stress, would reduce the clotting time of whole blood, using as one of his experimental situations stressful interviews. In another study, SCHNEIDER (1951) pointed out that day-to-day observations in individuals who suffered from thrombophlebitis would reveal accelerated clotting on days of stress. He emphasized that shortened clotting times would occur only in the presence of a "pressor response," that is, a rise in arterial blood pressure. MACHT (1952) found an acceleration of the clotting process in those blood donors who, when waiting to have their blood taken, were anxious, apprehensive, and highly nervous. Only SCHNEIDER's studies were carried out with silicon-covered test tubes.

MATERIAL AND METHODS

The subjects of this investigation were medical students on the morning of their final examination in Medicine. They represented an essentially unselected group, since none of the class when requested to take part in the study, failed to consent; only those students were excluded who would not subsequently be available for control examination. The students were examined between 9 and 11 a.m., and always when they had already started to examine the patients assigned to them. Some of them remarked spontaneously that if the observation of the reaction to emotional tension were the purpose of this study, this was certainly the right moment.

The arterial blood pressure, a total eosinophil and thrombocyte count were taken. Eosinophil counts were done using a 0·01% eosin–5% acetone stain in distilled water, the thrombocyte counts

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using as the diluent a 1% sequestrene (disodium-ethylenediamine-tetraacetic acid) in 0·8% sodium chloride solution. About 12 ml of blood, only when taken by technically satisfactory venepuncture, were immediately used for determination of the clotting time, according to the Lee-White method, by putting 1 ml into each one of two glass test-tubes and two siliconized tubes (size 100 × 10 mm). 4·5 ml were put into a tube containing 0·5 ml of a 1·1% sodium oxalate solution for the fibrinogen B test (CUMMINE and LYONS, 1948.) Syringes and puncture needles used for the clotting tests were siliconized* (MARGULIES and BARKER 1949) and used only once more after resterilization. The test tubes were observed in a water bath at 37°C, the minutes being counted from the time at which half of the required approximate 12 ml had been withdrawn into the syringe to complete clotting in the tube. The first glass tube was tilted every half-minute, the first silicon tube for the first time after 5 minutes, subsequently every minute; the second glass and second siliconized tube respectively were examined only after the first ones had shown complete coagulation. The remainder of a few millilitres of blood, being the first withdrawn and therefore possibly contaminated with tissue thromboplastin, were discarded.

For the fibrogen B test, five drops of a 2% solution of beta-nephthol in 50% alcohol were added to 1 ml of oxalated plasma, and the finding of a precipitate after 5 and 10 minutes was looked for. No precipitate appears on addition of the reagent to normal plasma within this period of time. The reaction is graded as negative, one or two plus according to the intensity of the precipitate formed.

The control examinations were performed after 24 or 48 hours in most cases, in some a few days later, but always during the same morning hours.

RESULTS

The results of these examinations in thirty-six students are summarized in Table 1. In three, a complete follow-up examination could not be done for technical reasons. Four males and three females showed no increase of the eosinophil counts, following the examination, five of them when examined 24 hours after the first test. On the other hand, twenty-eight showed, frequently within 24 hours, a rise in their eosinophil counts amounting in one instance (9) from zero to 242! It may be mentioned that several subjects explained to us that the general effect of stress had not yet completely subsided after 24 hours, and some had spent a sleepless night following their examination, though successfully passed.

Only in twenty-two students are pre- and post-examination thrombocyte counts available: they demonstrate no difference exceeding the limits of error of the method used.

As to the evaluation of results in all modifications of the Lee-White method, the last tube, in our case the second, is the one in which clotting is likely to take its least disturbed course. We have, therefore, taken the result of the second tube mainly as most suitable for comparison.

Most values obtained in glass tubes during the examination are within the range of normal (5 minutes and above), except possibly in two instances (11, 12). A definitely higher value, the difference exceeding 3 minutes, was obtained in the post-examination figure in seven instances (5, 6, 9, 11, 12, 27, 30). Samples 5 and 12 did not exhibit this relative shortening of their coagulation times in siliconized tubes.

In twenty-two instances, i.e. in more than half of the students examined, there was an increase in coagulation time in the siliconized tubes in the second test. This difference was one of three minutes in three cases (7, 16, 30) and of 4 minutes and more in the other nineteen, including results where the second figure was almost double the value of the first test or more. Clotting times below 15 minutes as determined in

* Silicone resin, Drifilm 9986, General Electric Corporation.

TABLE 1—RESULTS OF CLOTTING TESTS IN GLASS AND SILICONIZED TEST TUBES, OF EOSINOPHIL AND THROMBOCYTE COUNTS AND BLOOD-PRESSURE MEASUREMENTS IN THIRTY-SIX STUDENTS DURING AND AFTER THEIR EXAMINATION IN MEDICINE.

Student No.	Sex	Glass coagulation Time		Silicone coagulation Time		β-naphthol test		Eosinophil count per mm³		Thrombocyte count per mm³		Blood pressure (mm Hg)	
		during	after	during	after	after	after	during	after	during	after	during	after
1	m	6^{30}–$7^{30'}$	4^{30}–$5^{30'}$	17–18′	15–19′	0	0	11	0			135/80	125/70
2	m	5^{30}–$7^{30'}$	6^{30}–$8^{30'}$	12–14′	14–15′	0	0	11	11			130/80	115/80
3	m	8^{30}–$8^{30'}$	8′–10′	12–12′	21–32′	0	0	11	77			170/100	130/95
4	f	7^{30}–9′	7′–10′	15–19′	17–20′	0	0	44	11			100/70	110/70
5	f	5^{30}–6′	6^{30}–$9^{30'}$	13–16′	11–14′	0	0	220	110			95/60	100/60
6	f	6^{30}–$6^{30'}$	8–10′	9–12′	18–22′	0	0	0	77			110/80	95/60
7	m	4^{30}–7′	7–$9^{30'}$	14–17′	18–20′	0	0	0	110			125/75	110/70
8	m	4–5′	—	8–11′	—	0	0	22	0			—	—
9	m	6–6′	$8–11^{30'}$	10–13′	17–25′	0	0	0	242			135/75	130/80
10	m	5–5′	7–$7^{30'}$	12–14′	18–19′	0	0	44	253			125/80	105/60
11	m	3–$4^{30'}$	6–8′	10–10′	17–20′	0	0	143	253			125/90	110/65
12	m	4–$4^{30'}$	$5^{30'}$–8′	9–12′	13–13′	0	0	44	143			130/80	115/70
13	f	6–7′	6–8′	13–19′	15–15′	0	0	77	44	195·000	174·000	110/80	—
14	m	5^{30}–6′	4^{30}–5′	15–16′	12–15′	0	0	44	176	186·000	223·000	140/100	130/90
15	m	5–7′	6^{30}–9′	17–19′	12–17′	0	0	22	77	150·000	155·000	130/90	100/75
16	m	4–$6^{30'}$	5^{30}–$8^{30'}$	11–14′	15–17′	0	0	22	198	201·000	221.000	125/85	100/75
17	m	4^{30}–6′	—	14–8′	—	0	0	99	132	196·000	227·000	115/80	135/95
18	f	—	—	—	—	—	—	22	77	178·000	240·000	120/80	110/75
19	m	4^{30}–$6^{30'}$	6–6′ 6–8′*	10–13′	10–13′ 17–30′*	0	0 0*	66	88 186*	247·000	237·000	125/80	120/80
20	f	5–7′	5–7′*	8–8′	17–17′*	0	0*	0	110*	220·000	—	110/75	—
21	m	9–$10^{30'}$	5^{30}–7′*	14–19′	26–31′*	0	0*	0	99*	182·000	212·000*	125/80	105/75*
22	f	6–$9^{30'}$	6–8′*	13–13′	14–24′*	0	0*	0	66*	232·000	200·000*	115/80	100/70*
23	m	6–6′	6–9′	11–15′	13–19′	0	0	55	148	211·000	184·000	120/85	120/80
		—	5^{30}–7′*	—	19–28′*	—	0*	—	—	—	—	—	110/80*
24	m	7–10′	$6–6^{30'}$	15–16′	11–22′*	0	0*	0	147*	—	—	145/90	110/85*
25	m	4^{30}–$7^{30'}$	5–7′*	12–14′	18–21′*	0	0*	11	11*	—	—	130/90	110/80
26	f	5^{30}–$6^{30'}$	6–8′*	15–15′	12–18′*	0	pos.	11	132*	232·000	191·000*	130/95	115/80*
27	m	5–5′	9–12′*	18–19′	20–22′*	0	0*	88	0*	210·000	224·000*	145/95	125/80*
28	f	5–7′	5^{30}–$8^{30'}$*	14–15′	10–16′*	0	pos.*	11	88*	243·000	217·000*	130/90	105/80
29	f	5^{30}–$7^{30'}$	4^{30}–6′*	9–11′	16–17′*	pos.	0*	66	374*	145·000	170·000*	130/80	100/80*
30	f	5–5′	8^{30}–$9^{30'}$*	10–10′	13–13′*	0	0*	0	44*	187·000	259.000*	115/75	120/80
31	m	6^{30}–8^{30}	6^{30}–$9^{30'}$*	10–12′	16–20*	pos.	0*	11	154*	162·000	146·000*	120/65	105/80*
32	m	6–8′	5^{30}–$6^{30'}$* 5–7′*	12–14′	13–18′* 15–18′*	pos.	0* 0*	121	44* 132*	167·000	191·000	125/85	145/100*
33	m	5^{30}–6^{30}	6–9′*	7–7′	15–16′*	pos.	0*	66	154*	32·000	24·000	130/85	160/80*
34	m	8^{30}–$9^{30'}$	5^{30}–$8^{30'}$*	13–15′	14–20′*	pos.	0*	88	330*	168·000	185·000*	130/80	120/85*
35	f	5–8′	6–6′*	7–14′	10–14′*	pos.	0*	22	55*	256·000	240·000*	120/80	115/70*
36	m	5–7′	6–9′*	9–12′	13–14′*	pos.	0*	—	165*	179·000	138·000*	110/70	105/75*

*Control test taken later than 24 hours after the examination.

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silicon tubes are certainly short and the ones below 20 minutes may also still represent abnormally low values for normal individuals.

In twenty students, accelerated clotting and eosinopenia appeared together under the stress of the examination.

It deserves mentioning that of the five individuals who had lower eosinophil figures after the examination, only two (5, 27) had a longer coagulation time after the examination, the first in the glass, the second in the siliconized tube, whereas the other three failed to show a significant increase in clotting-time following their examination; one of them (13) even exhibited faster coagulation the day after the examination together with a slightly lower eosinophil count. Disregarding minute fluctuations, twenty-three students, therefore, exhibited an essentially parallel response in eosinophil count and silicon coagulation time.

As Table 2 shows, there is a very significant decrease of glass coagulation time, silicone coagulation time, and of the eosinophil counts, comparing examination with post-examination values.

TABLE 2.— STATISTICAL EVALUATION OF RESULTS OF EXAMINATION AND POST-EXAMINATION CLOTTING-TIME DETERMINATIONS AND EOSINOPHIL COUNTS PERFORMED DURING AND AFTER EXAMINATION IN MEDICINE IN THIRTY-SIX STUDENTS

Increase in glass coagulation time	1·23 ± 0·41 SD after examination
Increase in silicon coagulation time	5·1 ± 0·81 SD after examination
Increase in eosinophil counts	85 ± 15 SD after examination

The fibrinogen B test was positive in seven students during their examination and negative in the control tests. The only two positive post-examination results were observed in two girl students who had appeared for the control tests in a great hurry and immediately after a car journey from Tel Aviv to this city, a distance of about 70 km., passing from sea-level to a height of about 800 meters above sea-level.

Whereas most students exhibited an increase in pulse pressure during their examination, only four reached hypertensive levels under the stress of the examination (3, 14, 24, 27). Only three students (3, 17, and 32) had such a value afterwards, one of them (3) a known hypertensive who had entered the examination for the second time because of previous failure.

Student 1 had also previously failed and was under great stress this time; he felt distinctly that tension had not worn off yet 24 hours afterwards. A girl student (4) explained to us that she was extremely dissatisfied with her performance and her marks, and reproached herself for having argued with one of the examiners. Student 13 spent a sleepless night after her examination, as for instance also No. 14, who, however, showed a slightly different reaction in vitro. Student 19 had his control examination taken one day after the examination in Medicine; this happened to be the day prior to an examination in Surgery which he had inscribed for: he then showed almost identical values, but a few days afterwards his silicon time had risen to 30 minutes, his eosinophils to 186, instead of 13 minutes and 66 eosinophils respectively. Student 33 is known to show thrombocytopenia of a so far unexplained nature.

DISCUSSION

A significant decrease of the absolute eosinophil count—as pointed out by us before—seems rather frequently to accompany this type of stress. A state of accelerated blood coagulation can be shown under these circumstances; it can be demonstrated

in about a fourth of the cases in glass tubes, but in over half by the use of the more sensitive method of employing siliconized test-tubes.

Only a few students showed a significant rise in blood-pressure responses during the examination, and in contrast to SCHNEIDER'S (1950; 1951) observations, hypercoagulability could be demonstrated frequently even in the absence of a hypertensive blood pressure.

We are at present unable to evaluate adequately the finding of a fibrinogen B fraction in some of these healthy students under the stress of the examination. The fibrinogen B test as devised by CUMMINE and LYONS in 1948 has been a subject of controversy. LYONS assumes that a thrombin A has acted on fibrinogen A, thus transforming it into fibrinogen B, a form of fibrinogen in which it becomes demonstrable through the addition of naphthoquinon to oxalated plasma. The finding of fibrinogen B then, according to these authors, implies the presence of a prethrombotic condition, especially when associated with a shortened clotting time, demonstrated by them in glass tubes. CUMMINE and LYONS (1948) found this reaction frequently positive in the post-operative state, during the course of severe systemic disease, infections, and circulatory disorders. The occasional positive results of this test as observed in this series call for further observations.

The lack of change of the thrombocyte level has to be noted in relation to the stress situation as examined here.

A significant, sometimes striking decrease in the number of blood eosinophils as well as a state of accelerated blood coagulation seem to occur frequently under the emotional stress of the type of final examination studied. Hypercoagulability represents one of the factors which may contribute to thrombosis formation.

SUMMARY AND CONCLUSIONS

In order to study the influence of emotional stress on coagulation time, blood eosinophil, and thrombocyte counts, and the finding of a so-called fibrinogen B fraction in the plasma, thirty-six students were examined during their final examination in Medicine.

With the glass-tube method (Lee-White) accelerated clotting was found in seven instances; in siliconized tubes such a state of increased coagulation over the control test could be demonstrated in twenty-two instances.

The occasional finding of a fibrinogen-B fraction at present does not permit any interpretation.

The previously described "emotional eosinopenia" was found in the majority of students.

Thrombocyte counts during and after the examination showed no significant variation.

An increase in pulse pressure was usual during examination, but a rise of the arterial blood pressure above 140/90 mm Hg was only occasionally seen.

The state of accelerated coagulation, accompanying the stress response in these students, apparently did not always subside after 24 hours.

The findings presented might serve to cast some light on one of the aspects of thrombosis formation under emotional stress.

Acknowledgements—My thanks are due to Dr. J. MENCZEL and to Mrs. MIRIAM SCHWARZ for their help in carrying out this study, to Dr. SH. DICKSTEIN for the

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statistical calculations, to Hadassah Medical Organization and the Hematology Research Foundation of Chicago for the funds made available, and, last but not least, to the students for their kind co-operation.

Part of this material has been the subject of a short preliminary communication in "Harefuah" (Hebrew Medical Journal).

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 258 to 272. Pergamon Press Ltd., London

AN EXPERIMENTAL STUDY OF PSYCHOGALVANIC REFLEX RESPONSES OF NORMAL, NEUROTIC, AND PSYCHOTIC SUBJECTS*

S. B. G. EYSENCK

1. INTRODUCTION

THERE have been a great many studies using the P.G.R. basal and change scores† as measures of emotion. Some writers have concentrated on the abnormal field, testing psychotic patients (ODEGAARD, 1930, 1932; DARROW and SOLOMON, 1934; SOLOMON, DARROW, and BLAUROCK, 1939; HOCH, KUBIS, and ROUKE, 1944; FREEMAN and PATHMAN, 1943–1944). Among them FREEMAN and PATHMAN also used neurotic patients, and SOLOMON and FENTRESS (1934) carried out a specific study with the P.G.R. on neurotic subjects. WENGER (1948) used the P.G.R. as one measure of autonomic imbalance in his neurotic group. The rest of the studies of interest to us are concerned with the best units to employ when scoring the P.G.R., and these have been carried out on normal groups only (FREEMAN and KATZOFF, 1942; HAGGARD, 1949; LACEY, 1947; LACEY and SIEGEL, 1949; CHAMPION, 1951; PAINTAL, 1951; ELLIOT and SINGER, 1953). There are five outstanding reviews in this field by PRIDEAUX (1920), LANDIS (1932), DARROW (1937), MCCURDY (1950), and MCCLEARY (1950).

Unfortunately most of this work has led to more, rather than less, confusion. There is remarkably little agreement, as this quotation from LANDIS (1932) will indicate: "SYZ found increased psychogalvanic activity in dementia praecox. WESTBURGH, ODEGAARD, and SYZ and KINDER found decreased activity . . . . With respect to catatonia, SYZ, WESTBURGH, ODEGAARD, and SYZ and KINDER reported decreased galvanic activity, while RICHTER, SYZ, SYZ and KINDER, WESTBURGH, and WESTBURGH and EYMAN reported increased electrical resistance in the body . . . . For manic-depressive insanity, SYZ, WESTBURGH, and SYZ and KINDER reported decreased galvanic activity, while ODEGAARD reported an increased variability in this activity. With respect to the electrical resistance of the body in this syndrome, SYZ, and SYZ and KINDER reported an increase, while RICHTER reported that the resistance was the same as normal."

Furthermore, the situation does not seem to have improved very substantially since then, as later reviews show. This long-standing lack of agreement in the field is not altogether surprising, however, when the technical difficulties are considered. For a start, there is confusion as to the type

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† The term P.G.R. (psychogalvanic response) as used in the literature refers indiscriminately to two rather different measures, namely, the basal score and the change score. The term basal may refer to one of three things. It may mean "at the beginning of the whole experiment," it may mean "before any particular stimulus is applied," or it may refer to a hypothetically "pure" score unaffected by any previous stimuli and ongoing thought processes. According to the first usage, there is only one basal conductance score. According to the second usage, there are as many different basal scores as there are experimental stimuli. In this paper the second definition has been used, as it appears to be psychologically more meaningful than the first. The third definition mentioned was rejected as experimentally unobtainable and operationally meaningless.

Change scores referred to the displacement of conductance or resistance from the basal level, produced by experimental stimuli. The relationships between change scores and basal scores are complex and will be discussed in the body of the article.

of phenomenon under consideration, as the very lucid exposition of the physiology of the P.G.R. by McCLEARY (1950) shows. Next, it is unfortunate that experimental studies reported in the literature were not carried out with more care and fewer technical imperfections. Failure to use sufficient numbers of subjects in the groups for the data to give meaningful comparisons seems to occur in too many cases (e.g. FREEMAN and PATHMAN, 1943–1944, used 11 dementia praecox cases, 15 manic depressives, 4 neurotics, and 24 normals. ELLIOT and SINGER (1953) used 32 normals; and WALLER (1919) observed *one* subject only. But this is by no means the most serious difficulty.

There appear to be hardly more than two studies in which the same scoring system was employed, and this may indeed be the cause of at least some of the conflicting results reported. ODEGAARD (1930, 1932), for instance, while he used reasonably large groups (182 normals, 344 psychiatric patients) scored in terms of the "total curve"; he writes, "Most attention is paid, not to the individual psychogalvanic 'reflexes', but to the shape of the waves and their way of succeeding each other, i.e. to the type of psychogalvanic reactivity . . . . Regarded in this way the psychogalvanic curve becomes a sort of simple, graphic picture of the stream of mental activity (from its emotional-vegetative side) while the individual is subjected to a standard stimulation." Nobody seems to have followed this "scoring system" so that his conclusions stand alone. Similarly, DARROW and SOLOMON (1934) and SOLOMON, DARROW, and BLAUROCK (1939) dealt with both blood pressure and P.G.R. readings in neurotics and psychotics respectively, but set their data out in terms of galvanic reactivity on a three-point scale; "under galvanic reactivity the number 1 means maximum reaction less than 2000 ohms, 2 less than 5000 ohms, and 3 greater than 5000 ohms." PAINTAL (1951) devized his "Paintal index" system of scoring (GSR $\times$ 100)/MGSR, where GSR = galvanic skin response in ohms; MGSR = maximum skin response (obtained by firing a pistol shot, this producing the maximum possible deflection in all subjects), to show that basal resistance bore no relationship to this percentage. He used 450 psychotics and an equal number of normals in this study. One confirmatory report has appeared in which ELLIOT and SINGER (1953), using 32 normals only, listed the following three correlations of basal resistance: with GSR = 0·412, with MGSR = 0·401, and with the Paintal index = 0·061. No two writers seem to have used the same methodology in presenting stimuli. Even within a single study, different stimuli have been used for different subjects. HOCH, KUBIS and ROUKE (1944), for example, proceeded as follows: "An individual list of questions was prepared for each subject, who was instructed to answer each question at most in one phrase, or by a 'yes' or 'no'." They attempted to score the P.G.R. curves obtained while giving these psychiatric-interview-type of questionnaires, by phrases like "This is the record of a distracted person", and "This record shows the characteristics of a lie reaction in a normal individual." Perhaps it is as well that they finally concluded that: "Though the results of this investigation are suggestive and encouraging, the P.G.R. cannot give an absolute diagnostic statement." The same technique was used by SOLOMON, DARROW, and BLAUROCK (1939), who obtained blood pressure and galvanic measures during a psychiatric type of interview, and reported their results in terms of log conductance changes "small, medium, and large."

Some clarification of the scoring and unit confusion was attempted by later writers. HAGGARD (1949) suggested the use of log conductance units, since they showed minimal relationship between basal and change scores. CHAMPION (1951) similarly tried to establish a proper unit for the P.G.R. change scores, the commonest criteria of an appropriate unit being normal distribution of the scores and independence of basal level from change score. FREEMAN and KATZOFF (1942) investigated the recovery quotient and the P.G.R. units in general; but probably the most helpful work was done by LACEY (1947) and LACEY and SIEGEL (1949). They investigated the relationship between basal level and change scores transposed into various units in an attempt to obtain low correlations between them, while still observing the requirements of normally distributed scores.

Even when the questions of methodology and scoring are agreed upon, many of the studies comparing normal and abnormal groups still lack proper statistical analyses of the data. Lastly, an important outside variable has mostly been neglected. VENABLES (1955) found that temperature and humidity were correlated with P.G.R. scores, and furthermore reported that although the regression between temperature and conductance was linear for normals, different results were given by abnormal groups. That sweating and temperature and humidity are related is obvious, and on this account alone these variables should always have been considered; but the finding that temperature and/or humidity may affect one group (neurotics) more than another is quite vital to the interpretation of any results on the P.G.R. used with abnormal groups. Similarly WALLER, as far back as 1919,

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reported diurnal periodicity, with basal P.G.R. scores higher during the night than the day; this is perhaps worth following up, although WALLER himself only used one subject to substantiate the claim.

Briefly, then, the studies reported in the literature on the P.G.R. have not, on the whole, been models of correct procedure. Some have used too small numbers, others have been scored by "observing curves," many failed to consider the relationship between basal level and change scores, or the distribution of the scores, most have not concerned themselves with statistical treatment of their data, while some have nevertheless measured changes in curves of the P.G.R., among individuals each of whom was interviewed with different material. Finally, most of their authors have ignored the possible influence of outside variables like temperature and humidity.

In spite of these criticisms, however, there appears to be some slight agreement that neurotics as a group show greater responsiveness on the P.G.R. than do psychotics, although they do not seem much differentiated from normals. Some experiments, notably those of WENGER (1948), suggest that neurotics are distinguished from normals also, showing lower basal P.G.R. scores and possibly greater responsiveness (higher change scores). These suggestions were utilized in setting up our own hypothesis. Neurotics, normals, and psychotics show basal P.G.R. scores of increasing magnitude, and P.G.R. responses to stimuli of decreasing magnitude. Little confidence was felt that these hypotheses would be borne out at a reasonable level of significance but the theoretical position is so unclear that no realistic alternative presented itself.

2. POPULATION AND CONDITIONS OF TESTING

In choosing the control group, the main aim was to avoid subjects suffering from serious mental disorders of any kind. The difficulty arises from the fact that psychoticism and neuroticism are considered to be present to some extent in everybody (EYSENCK, 1952). These mental disorders are each measurable along a continuum, with "normals" very little affected by symptoms from each category and the hospitalized groups possessing far more symptoms which group into syndromes leading to their diagnoses into a particular category. With this in mind we laid down as our main criterion for inclusion into the "normal" group, that the subjects should never have been interviewed by a psychiatrist except when army selection procedures of some kind necessitated it; none of the individuals themselves were to have sought psychiatric help.

After this arbitrary ruling we decided that the control group should be as representative a sample of the general population as we could obtain, and consequently four separate groups were tested. The first was an all-male group of 30 soldiers from the Royal Army Educational Corps, the members of which were all highly intelligent and very stable. They were nearly all National Service recruits and mostly had received extensive educational training which enabled them to try for a commission in the army. Their ages were between 18 and 39 years. The second male group was also from the army, but was composed of 29 soldiers who were going through a reallocation depot at the time; they were mainly "regulars", i.e. volunteers as opposed to National Service men, and hardly any of them were educated beyond the usual school-leaving level. They were of low intelligence on the whole and seemed somewhat lacking in stability for a control "normal" group. This impression of the group, of which this was a sample, has been confirmed experimentally by others (GRAVELY, 1950; EYSENCK, 1952). Their ages ranged from 18 to 45 years.

The two female groups we chose were relatively midway between the army groups with respect to intelligence and stability. The first was a group of 29 student nurses from King's College Hospital

who were of average intelligence (or above) and seemed both stable and co-operative. Their ages ranged from 19 to 28 years. The second female group was composed of 35 student occupational therapists from the Maudsley Hospital; they too were of average intelligence (or above) and made a stable and co-operative impression. Their ages ranged from 19 to 33 years.

An attempt was made to match the controls against the abnormal groups for sex, but to do so for age and intelligence proved impossible. The average age of the control group was 22 years, that of the neurotic group 30 years, and the psychotic group 39 years. Similarly the average intelligence of the three groups, as measured by the abstraction part of the Shipley-Hartford scale of deterioration, was 14·886 for the control group, 11·927 for the neurotics, and 8·255 for the psychotics (raw scores).

An attempt was made, instead of matching for age, to show its relative unimportance in accounting for the differentiating powers of the P.G.R. between groups by correlational methods. The correlations of the main P.G.R. scores used with age and intelligence are shown in Table 1. It will be seen that none of the correlations with intelligence are significant. Age does seem to have given rise to a slight correlation with basal resistance in the normal group, but since this is only significant at the 5% level and neither of the abnormal groups reflected a similar correlation for this score, there does not seem sufficient cause to assume that age might be an important influence as far as P.G.R. scores are concerned.

The abnormal groups consisted of inpatients of the Bethlem Royal and Maudsley Hospitals. Their ages ranged from 16–49 years for the 24 male neurotics (of whom 8 were hysterics and 16 were

TABLE 1.—CORRELATIONS FOR AGE AND INTELLIGENCE WITH LOG BASAL RESISTANCE

	Control	Neurotic	Psychotic
Age	−0·246*	−0·036	−0·115
Intelligence	0·194	−0·075	0·055
	$n = 123$	$n = 54$	$n = 51$
	Significance of correlations		
	5%	1%	·1%
Controls	0·195	0·254	0·321
Neurotics	0·262	0·339	0·426
Psychotics	0·273	0·354	0·443

In the remainder of the tables correlations significant at the 5% level are marked with an asterisk, correlations significant at the 1% level are marked with a dagger, and correlations significant at the 0.1% level with a double dagger.

dysthymics*; from 19–50 years for the 31 female neurotics (of whom 7 were hysterics and 24 dysthymics); from 15–48 years for the 13 male schizophrenics; from 17–49 years for the 15 female schizophrenics; from 33–57 years for the 12 male psychotic depressives, and from 24–64 years for the 15 female psychotic depressives.

It was stressed, to the psychiatrists responsible for the selection of cases, that we required patients whose diagnoses were primarily either neurotic or psychotic, so that as few mixed cases as possible were seen. The subdivisions were mentioned, but although an effort was made to be reasonably sure of the schizophrenic-depressive distinction as well as the hysteric-dysthymic one, the main stress lay on the basic categories, neurosis and psychosis. Patients were excluded where any doctor expressed some doubt as to the diagnosis with respect to neurosis or psychosis, as for example, in a case where a depression was considered reactive by some and endogenous by others. Each subject was tested in two sessions of about an hour each on a battery of tests which included the P.G.R. This was given at the end of the second session, and was introduced as a test of relaxation. It was of 30 minutes' duration.

* The term dysthymia was introduced by EYSENCK (1952) to characterize neurotics suffering from manifest anxiety, reactive depression, and/or obsessional symptoms. It is not dissimilar in meaning to the older and now obsolete term "psychasthenia".

3. DESCRIPTION OF TEST

The subject was asked to lie down on the couch, and relax. "This is a test to see how well you can relax" was, in fact, the introduction to the instructions. The electrodes were strapped on, one to each palm, by rubber bands, and the subjects were asked not to press their hands into a fist if possible. The P.G.R. apparatus was then switched on and no stimuli were offered for the next fifteen minutes, during which the subject lay quietly relaxing. He was then asked to draw in his breath (S_1),

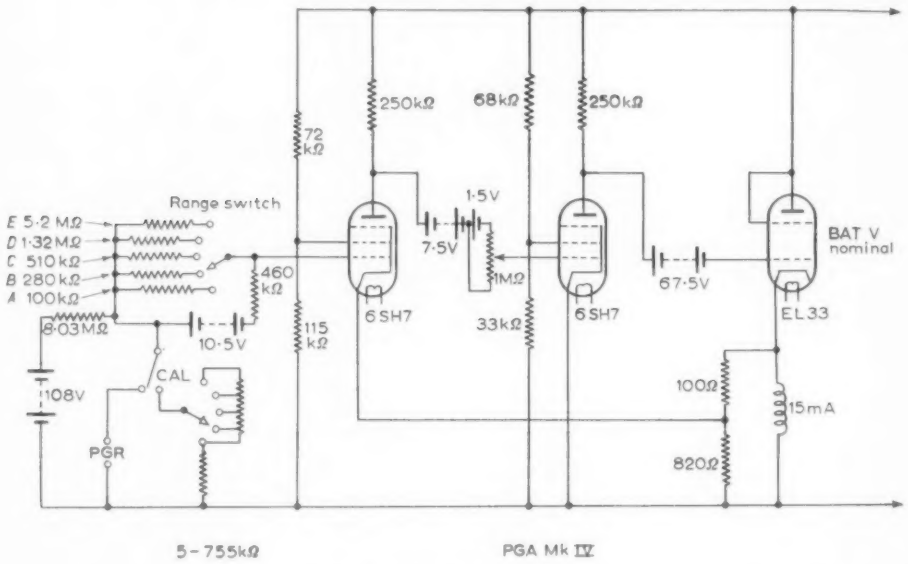

FIG. 1.—The circuit of P.G.R. apparatus used.

and then to relax again. After one more minute's rest, he was asked to respond by "yes" or "no" to the second half of the Maudsley Medical Questionnaire (S_2), the first half having been given earlier in conjunction with the Luria apparatus. The initial deflection caused by referring to the known questionnaire was measured as one of our most promising scores, constituting a kind of "threat" score. After the final items of the questionnaire had been read and answered (S_3) the subject was given a further minute's rest and an object was then dropped from a given height (S_4). After whatever deflection the noise had caused had died down and returned to the previous level the apparatus was switched off and the test was at an end.

The apparatus we used had the circuit shown in Fig. 1. The electrodes consisted of one-inch-diameter "domes of silence" mounted on sponge rubber pads, and attached to the subject's palms by means of thick rubber bands. No electrode jelly or paste was used. They were connected to the amplifier by a length of twin flex. The apparatus consisted of a three-stage direct-coupled amplifier, connected to a 15 milliamp pen recorder. The current through the patient was maintained constant at 14 microamps. There were five ranges covering from 0–1 Megohms. A set of calibration resistors was provided to enable calibration on each range of the instrument. The apparatus was calibrated before and after each record.

4. SCORING

There is a considerable literature dealing with the choice of the best units to be employed in the analyses of data obtained in connection with P.G.R. Two obvious requirements are that units should be distributed normally, as otherwise the usual statistical procedures cannot be employed, and that change scores should be uncorrelated with basal scores. Resistance scores in Kilohms, which constitute the basic data in our experiment, are known to give high correlations between basal score and change score, and are consequently not widely used. In addition it was found in the present experiment that the distribution was quite abnormal

LACEY and SIEGEL (1949) made a special study of the correlations of change scores with basal level in an attempt to find that unit for change scores which showed the least correlation with basal level. Their results are given in Table 2, which shows change in conductance to have the least correlation with the basal level of conductance; this they conclude was therefore the best unit to employ. (Conductance is the reciprocal of resistance, i.e., 1/resistance.) As their work was concerned entirely with normal subjects, and as they used a less varied sample of situations in their work than is represented here, it was decided to repeat their calculations in connection with our own data. Basal scores were uniformly transformed to log conductance units, and these were correlated with a variety of change scores. Care was taken to keep separate the calculations for control, neurotic, and psychotic groups, as it seemed possible that relationships might not be identical in these three groups.

TABLE 2.—CORRELATION OF GALVANIC CHANGE WITH BASAL LEVEL OF CONDUCTANCE IN FIVE NORMAL GROUPS (FROM LACEY AND SIEGEL, 1949)

	$n = 20$	$n = 21$	$n = 18$	$n = 16$	$n = 17$	Combined ($df = 77$)
Change in resistance (R)	−0·79	−0·73	−0·65	−0·70	−0·64	−0·71
Change in conductance (C)	0·08	0·25	−0·08	0·00	0·35	0·05
% change in R	−0·61	−0·57	−0·63	−0·68	−0·44	−0·59
% change in C	−0·54	−0·53	−0·53	−0·68	−0·54	−0·56
Log change in R	−0·91	−0·90	−0·74	−0·85	−0·85	−0·86
Log change in C	0·08	0·28	−0·02	−0·01	0·34	0·14
Change in log R	−0·58	−0·55	−0·60	−0·68	−0·59	−0·60

Table 3 shows correlations between basal conductance and change during the fifteen-minute rest period. It will be seen that contrary to LACEY and SIEGEL's (1949) findings, change in conductance shows high and significant correlations with basal conductance, for both the normal and neurotic groups. The best score appears to be percentage change in conductance, which has no significant correlations with basal conductance in any of the groups. This finding is not borne out by the figures in Table 4, which show correlations between basal conductance and changes during the first six minutes of rest.

In Table 5 are given the correlations between basal conductance (i.e. the last score before stimulus was applied) and the greatest change score obtained within twelve seconds after applying the breath holding stimulus (S_1). Change in conductance will be seen again to correlate very significantly with basal conductance,

TABLE 3.—CORRELATIONS OF LOGARITHM OF BASAL CONDUCTANCE WITH CHANGE SCORE AFTER 15 MINUTES' REST IN VARIOUS UNITS. ALSO *F*-RATIO VALUES AND LEVELS OF SIGNIFICANCE

	Control	Neurotic	Psychotic	*F*	% level
Change in conductance	0·557‡	0·572 ‡	−0·129	3·149	1·0
% Change in conductance	0·032	−0·243	0·234	0·004	n.s.
Change in resistance	0·181	−0·283*	−0·104	1·081	n.s.
% Change in resistance	0·218*	0·330*	0·268	1·118	n.s.
	n = 123	*n* = 54	*n* = 51		
Logarithm of basal conductance				8·297	0·1

TABLE 4.—CORRELATIONS OF LOGARITHM OF BASAL CONDUCTANCE WITH CHANGE SCORE AFTER SIX MINUTES' REST, IN VARIOUS UNITS. ALSO *F*-RATIO VALUES AND LEVELS OF SIGNIFICANCE

	Control	Neurotic	Psychotic	*F*	% level
Change in conductance	0·134	0·559‡	0·366†	3·951	5·0
% Change in conductance	0·223†	0·676‡	0·355†	2·608	n.s.
Change in resistance	0·247†	−0·688‡	0·064	1·866	n.s.
% Change in resistance	0·045	−0·408†	−0·162	2·623	n.s.
	n = 123	*n* = 54	*n* = 51		
Log basal conductance				8·297	0·1

TABLE 5.—CORRELATIONS OF LOGARITHM OF BASAL CONDUCTANCE (BEFORE BREATH-HOLDING STIMULUS) WITH GREATEST CHANGE SCORE WITHIN 12 SECONDS. ALSO *F*-RATIO VALUES AND LEVELS OF SIGNIFICANCE

	Controls	Neurotics	Psychotics	*F*	% level
Change in conductance	−0·579‡	−0·475‡	−0·383‡	4·337	1·0
% Change in conductance	−0·271†	−0·141	0·075	0·370	n.s.
Change in resistance	−0·316†	−0·439‡	−0·272	0·496	n.s.
% Change in resistance	−0·376‡	0·121	0·229	3·590	5·0
	n = 123	*n* = 54	*n* = 51		
Logarithm of basal conductance (before breath-holding stimulus				4·651	1·0

this time for the psychotics as well as for the controls and the neurotics. Percentage change in conductance, although significantly correlated with basal level in the normal group, again appears to be the best score.

Table 6 shows the correlation between basal conductance and change score one minute after the application of S_1. Change in conductance again appears to

TABLE 6.—CORRELATIONS OF LOGARITHM OF BASAL CONDUCTANCE (BEFORE BREATH-HOLDING STIMULUS) WITH SCORE AFTER ONE MINUTE. ALSO *F*-RATIO VALUES AND LEVELS OF SIGNIFICANCE

	Controls	Neurotics	Psychotics	*F*	% level
Change in conductance	−0·265†	−0·102	−0·447‡	0·715	n.s.
% Change in conductance	0·037	0·027	−0·180	0·485	n.s.
Change in resistance	−0·309†	−0·044	−0·127	0·986	n.s.
% Change in resistance	0·072	−0·043	0·041	1·626	n.s.
	$n = 123$	$n = 54$	$n = 51$		
Logarithm of basal conductance (before breath-holding stimulus)				4·651	1·0

be the worst score; percentage change in conductance and resistance the best. Similar results appear in Table 7 showing correlations between basal conductance and change scores 24 seconds after M.M.Q. threat. This result, however, contrasts with that shown in Table 8, in which are given correlations of basal conductance (i.e. the last score before administration of S_3), and the change score at the end of the questionnaire. All four types of change score will be seen to be significantly related to basal conductance for at least two out of the three groups; change in resistance is so correlated for all three groups.

The data leave a very confused impression. For any one stimulus, results obtained for the three groups of subjects are not always congruent. Thus in Table 3 we find a correlation of 0·56 between basal conductance and change in conductance for the normal group, a correlation of 0·57 for the

TABLE 7.—CORRELATIONS OF LOGARITHM OF BASAL CONDUCTANCE (BEFORE MAUDSLEY MEDICAL QUESTIONNAIRE) WITH SCORE AFTER 24 SECONDS. ALSO *F*-RATIO VALUES AND LEVELS OF SIGNIFICANCE

	Control	Neurotic	Psychotic	*F*	% level
Change in conductance	−0·347‡	−0·415†	−0·078	5·171	1·0
% Change in conductance	0·044	0·092	−0·137	0·653	n.s.
Change in resistance	−0·400‡	−0·499‡	−0·003	0·024	n.s.
% Change in resistance	0·081	−0·109	0·017	6·533	1·0
	$n = 123$	$n = 54$	$n = 51$		
Logarithm of basal conductance (before Maudsley Medical Questionnaire)				2·340	n.s.

neurotic group, but one of −0·13 for the psychotics. In Table 8, using again the correlation between basal conductance and change in conductance, it is the normal group that stands out from the two others, whereas in Table 6 it is the neurotic group. It seems very difficult to find any rational explanation for these results, which cannot be accounted for entirely in terms of sampling errors.

TABLE 8.—CORRELATIONS OF LOGARITHM OF BASAL CONDUCTANCE (BEFORE MAUDSLEY MEDICAL QUESTIONNAIRE, BUT AFTER "THREAT" SCORE) WITH SCORE AT END OF QUESTIONNAIRE, ALSO *F*-RATIO VALUES AND LEVELS OF SIGNIFICANCE

	Control	Neurotic	Psychotic	*F*	% level
Change in conductance	−0·088	0·303*	0·389†	0·312	n.s.
% Change in conductance	0·070	0·350†	0·361†	1·758	n.s.
Change in resistance	−0·531‡	−0·310*	−0·419†	0·820	n.s.
% Change in resistance	−0·469‡	−0·392†	0·032	0·413	n.s.
	$n = 123$	$n = 54$	$n = 50$		
Logarithm of basal conductance (before Maudsley Medical Questionnaire, but after "threat" score)				5·038	1·0

Comparing the different change scores we do find a certain amount of agreement; there is a distinct tendency for a change in conductance, i.e. the score preferred by LACEY and SIEGEL (1949) to give the worst results (to have the highest correlation with basal-conductance scores). Change in resistance also tends to be a rather poor measure. Percentage change in conductance emerges as the best followed by percentage change in resistance. These, however, are overall results; in individual cases, as for instance in Table 4, the percentage change scores actually give higher correlations than does change in conductance. Our general conclusion with respect to scoring is therefore that percentage change in conductance is the score most independent of basal conductance, but that much work remains to be done before we can even begin to understand the functions determining association between basal and change scores of the various kinds examined.

We must next turn to the discrimination between our three groups produced by the various scores. Analyses of variance were performed and are reported in the last two columns in Tables 3, 4, 5, 6, 7, and 8. It will be seen that the best discrimination was usually given by the basal-conductance score. Change scores tend to discriminate significantly between the groups only to the extent that they are themselves highly correlated with basal conductance. This effect is so striking that we are probably justified in concluding that the three groups are not differentiated with respect to psychogalvanic responses to stimuli, but only with respect to their basal conductances. This result is borne out by the general trend of score of the groups in Figs. 2 and 3.

Fig. 2 gives a plot of the average resistance scores of psychotics, neurotics, and controls during the fifteen-minute rest period. Fig. 3 shows the continuation of this plot for the remainder of the experimental period. It will be seen that throughout the psychotics have much higher resistance scores, while the controls and the neurotics are quite indistinguishable from each other. The only possible exception to this general rule appears to be the first few scores plotted in Fig. 2, where the neurotics have resistances almost as high as the psychotics and much higher than the normals. Starting out near the psychotic level the neurotics quickly approach the level of the controls which they reach after about five minutes.

In view of the very abnormal distribution of resistance scores it seemed desirable to make a proper statistical test of this apparently divergent course of the neurotic subjects during the first five minutes of the rest period. Resistance scores during

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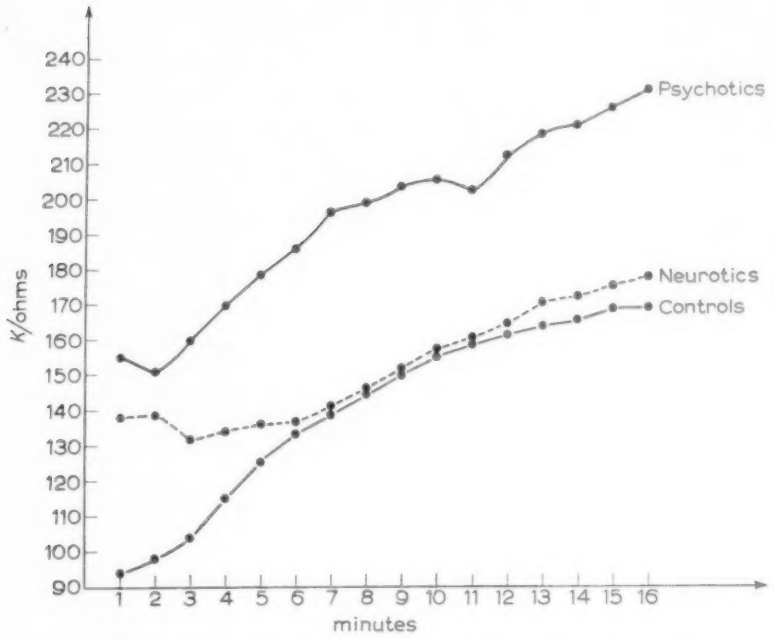

FIG. 2.—Resistance in kilohms of psychotic, neurotic, and normal groups during a 15 minute rest period.

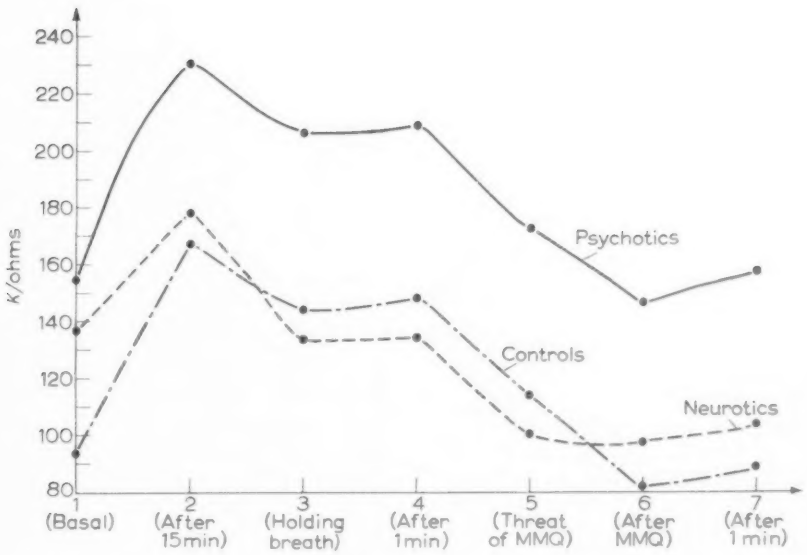

FIG. 3.—Resistance in kilohms of psychotic, neurotic, and normal groups during the course of the experiment.

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the first and sixth minutes were transformed into log conductance units and t tests carried out to test the significance of comparisons between all groups. The results are given in Table 9. Psychotics and controls are differentiated at both points at the 0·1% level. Neurotics are not significantly differentiated from psychotics at either point. Neurotics are significantly differentiated from controls at the beginning but not after five minutes. The results of these t tests suggest that the different behaviour of the neurotic group to that of the other groups, during the first five minutes of a rest period (as noted in Fig. 2), is not statistically significant. This conclusion was

TABLE 9.—RESULTS OF t TESTS BETWEEN THE THREE GROUPS FOR THE BASAL SCORE AND THAT AFTER FIVE MINUTES. BOTH IN LOG CONDUCTANCE UNITS

Groups	Log basal conductance	Log conductance after 5 minutes
Neurotics with psychotics	1·252	1·493
Neurotics with controls	2·512*	1·281
Psychotics with controls	3·938‡	3·006‡

confirmed by a direct comparison of the slopes (obtained by the equation: 1st score–6th score) of the abnormal groups only which did not differ significantly ($t = 1·305$, for d.f. = 104). The variances, however, were noted to be rather large, so that the possibility of obtaining a significant differentiation seemed more likely if all intermediary points (i.e. minute-interval readings) on the curve were considered. A comparison between the groups was, therefore, attempted using an analysis of variance technique. The results obtained are shown in Table 10. It will be seen that both F-ratio values are significant, the first representing the actual resistance levels (in a logarithmic transformation), and the second being a comparison between the slopes. When taking all six points of the curves into account, then, the groups can be demonstrated to differ very significantly, so that later studies using neurotic groups might find it worth while including a measure of the resistance trend during the first five minutes of a rest period.

Two further results are worth reporting. We took a score of restlessness during this test, which was simply the number of times the subject spoke, coughed, moved, or sighed in the half hour he lay on the couch trying to relax as instructed. The results show a very marked differentiation for the three groups (Table 11), with psychotics the most restless of the groups and the neurotics also inclined to be fidgety. This score was, of course, in no way derived from the apparatus and is only a by-product score, as it were. It may provide food for thought, nevertheless, to realize that this score differentiates much better between our groups than any of the other scores investigated.

Finally we took up the suggestion made by VENABLES (1955), that room temperature and humidity might be related in some way to the P.G.R. scores. We investigated the possible relationships between these variables and the log basal scores, but our data show no evidence of any linear or curvilinear relationship for the basal scores

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TABLE 10.—ANALYSIS OF VARIANCE RESULTS BETWEEN THE THREE GROUPS FOR COMBINED MINUTE INTERVAL READINGS DURING THE FIRST FIVE MINUTES OF THE REST PERIOD (IN LOG RESISTANCE UNITS)

Means for each occasion

	1	2	3	4	5	6	total
Controls	17·480	18·024	18·285	18·447	18·642	18·878	18·293
Neurotics	19·382	19·691	19·636	19·727	19·800	20·018	19·709
Psychotics	20·176	20·333	20·490	20·667	20·824	20·980	20·578

Source	Sums of squares	d.f.	Mean square var.
Total	25,657·325	1,373	
Variance between groups	1,269·854	2	634·927 (*m*)
Variance between individuals within groups	23,229·638	226	102·786 (*n*)
Variance between occasions, all groups combined	164·565	5	
Interaction group: occasion	21·041	10	2·1041 (*a*)
Residual error	972·227	1,130	0·8604 (*b*)

$F_1 = m/n = 6{\cdot}177$ (significant at the 0·1% level).
$F_2 = a/b = 2{\cdot}445$ (significant at the 1% level).

TABLE 11.—SCORE OF RESTLESSNESS (I.E. NUMBER OF MOVES ETC.).

Controls		Neurotics		Psychotics		*F*	% level
m	*v*	*m*	*v*	*m*	*v*		
0·528	1·464	2·407	14·057	5·098	32·890	33·503	0·1
$n = 123$		$n = 54$		$n = 51$			

TABLE 12.—RELATIONSHIPS BETWEEN BASAL CONDUCTANCE SCORE AND HUMIDITY

	Controls	Neurotics	Psychotics
Correlation coefficient (*r*)	−0·079	−0·072	−0·092
Linearity (*F*)	0·665	0·228	0·295
Curvilinearity (*F'*)	1·010	0·752	1·539
	$n = 123$	$n = 54$	$n = 51$

with humidity for any of the groups (Table 12). The same was found to be the case for temperature (Table 13) for the control and psychotic groups, but a correlation of 0·354 (significant at the 1% level) was obtained for the neurotic group only. (Even in this latter group, the evidence for a *curvilinear* relationship was negligible, being barely significant at the 5% level; the linear regression, however, was definitely significant.) This finding confirms VENABLES's discovery that it is with *neurotics* that temperature differences cause different P.G.R. reactions, rather than with other groups. Theoretically, this appears to be a very interesting effect, although at the moment any explanation could only be speculative.

TABLE 13.—RELATIONSHIPS BETWEEN BASAL CONDUCTANCE SCORE AND ROOM TEMPERATURE

	Control	Neurotic	Psychotic
Correlation coefficient (r)	0·057	0·354‡	0·154
Linearity (F)	0·336	5·223	0·956
Curvilinearity (F')	1·105	2·163*	1·191
	$n = 123$	$n = 54$	$n = 51$

5. CONCLUSION

It is a widely held hypothesis that neurotics are differentiated from normals by greater emotional lability and reactivity, and consequently by greater autonomic responsiveness. Our data fail to support this hypothesis; the neurotic group is not differentiated in terms of responsiveness but rather in their slower rate of "calming down". Neurotics have high resistances initially, though not quite as high as psychotics. They can be further separated from the psychotic group by considering the trend of their scores during the first five minutes of a rest period, which indicates that they are much slower to show an increase in resistance over the initial basal score than are either psychotics or normals, whose recovery is of equal rapidity.

Psychotics, conversely, are often believed to be hypoactive emotionally and autonomically, and this part of our hypothesis was borne out in so far as their response curves run at a higher level of resistance throughout the experiment. However, changes in resistance, consequent upon different stimuli, when calculated independently of basal scores, did not differentiate psychotics from normals or neurotics as might have been expected from this general hypothesis.

With respect to the units in which change scores can best be expressed, our findings did not accord with those of other investigators. It proved impossible to find change scores which (1) had low correlations with basal scores and also (2) produced significant differences between the three groups. Correlations between different change scores differed from group to group for any given stimulus and from stimulus to stimulus for any one group in a manner quite unpredictable and impossible to reduce to any consistent rule. It would seem that little progress is likely to be made in working with the P.G.R. until the theoretical issues raised by these findings can be resolved.

SUMMARY

The P.G.R. test was given to 123 normal control subjects, 55 psychotics, and 55 neurotics. Subjects spent the first fifteen minutes of the test resting on a couch; after this period various stimuli were applied in order to study changes in the subjects' resistance. An effort was made to find change scores which would give *low* correlations with basal scores and yet differentiate well between the groups. It was found that (1) psychotics had significantly higher resistance scores than the other groups, (2) neurotics could not be discriminated from normal subjects on any except one score, and (3) change scores discriminated between the groups only by virtue of their correlations with basal scores. (4) Room temperature and humidity were measured and related to P.G.R. scores for each of the three groups. In line with previous work a significant relationship between P.G.R. and temperature was found for the neurotic group only.

Acknowledgements—The writer is indebted to the Bethlem Royal and Maudsley Hospitals Research Committee for a grant which made this study possible.

Thanks are due to Professor H. J. EYSENCK for his many helpful suggestions and his willingness to discuss queries at all times; and to Mr. A. E. MAXWELL and Mr. P. SLATER for their patient help over the statistical treatment of the data.

Finally, the help should be acknowledged of the doctors and nurses of the Bethlem Royal and Maudsley Hospitals for selecting suitable patients for testing; and also of all the subjects who so willingly underwent the testing procedure.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 273 to 286. Pergamon Press Ltd., London

PROGNOSTIC VALUE OF ADRENALINE AND MECHOLYL RESPONSES IN ELECTROCONVULSIVE THERAPY*

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INTRODUCTION

Autonomic balance has been extensively investigated in both manic depressive and schizophrenic psychoses. Hoskins (1934) and Freeman (1932, 1933) have commented on the "sluggishness" of the response of the sympathetic system in schizophrenia, while there are references to a similar reduction of activity in the parasympathetic system of the depressive (Henry 1931; Strongin and Hinsie, 1938). However, the significance of these findings remains obscure.

In the past few years Funkenstein and his colleagues have published a number of papers correlating blood pressure and subjective emotional experience in response to injections of adrenaline and mecholyl with the outcome of ECT. Although the emphasis of their work has changed somewhat with its historical development, their last definitive opinion (Funkenstein *et al.*, 1952b) was to the effect that there would be a good outcome to treatment where a prolonged and considerable fall to mecholyl took place in the presence of an adequate rise following the injection of adrenaline. Conversely, falls, brief or small, following mecholyl injection, were associated with a poor prognosis. The presence of adrenaline precipitated anxiety judged by subjective and objective consideration, worsens the prognosis whether the mecholyl fall is large or small. On the other hand, mecholyl precipitated anxiety and chills, are felt to be good prognostic signs.

The test has been granted theoretical support by Gellhorn's (Gellhorn, 1953) theory of central sympathetic reactivity. Alexander (1955) and Brothers and Bennett (1954) have reported favourably on its help in treatment decisions. However, attempts to apply the test to other therapies such as electrostimulation (Montague and Davies, 1955) and carbon dioxide therapy (Simon and Hopkins, 1953) have not been so successful. Most authors have modified the use of the test or the scoring methods in some way. Recent work (Funkenstein, 1956; Geokaris and Kooiker, 1956) suggests that the duration of stay in hospital is important in determining the autonomic response. Patients recently admitted to hospital have a different distribution of response curves to those who have been in for somewhat longer. The implication of this for the prognostic claims of Funkenstein which were tested largely with acute admissions is at present unclear.

There have been few publications exclusively devoted to the use of the test in ECT, though there is every indication from casual conversation that the test has been widely, if fleetingly, submitted to trial.

In view of the test's practical importance, if confirmed, we have carried out a

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modified but similar study at the Bethlem Royal and Maudsley Hospitals, and are able to report three series.

Method and Clinical Material

The method differed in the following ways from that of FUNKENSTEIN; we abandoned the intravenous saline injections on the first day; we gave adrenaline and mecholyl on the same day in the largest series though on independent days in the second and third series. Testing was carried out in a clinical setting by nurses with experience in sphygmomanometry to whom the patients were accustomed (REISER *et al.*, 1955).

One hundred and eleven patients who were routine admissions (including those to the Day Hospital) were tested. There were 44 males and 67 females, with a mean age of 41·2 years, ranging from 22 to 62. Of these, 59 were suffering from the depressive phase of manic-depressive psychosis, 8 from involutional psychosis, 12 from schizophrenia, 10 from schizo-affective psychosis and 22 from mixed neuroses* and/or character disorders. (See appendix Table 1.)

To avoid sampling errors all patients coming to E.C.T. were tested except (a) those who were too restless, or who had suffered from severe cardio-vascular, cerebrovascular or other serious diseases, (b) those with resting systolic blood pressure over 140 mm. Hg who were given only mecholyl, and are reported separately in this paper, (c) patients on tranquillizing drugs (SCHNEIDER, 1955).

Decisions about treatment, and clinical responsibility were in the hands of independent physicians. Patients received between 2 and 19 electroconvulsive treatments, an average of 7·5 for those who recovered and 8·9 for those who did not. Treatment was discontinued in 4 unfavourable cases after acute anxiety or manic excitement occurred.

E.C.T. was given by the Strauss-MacPhail Plexacon machine, using a standard technique of 30 joules, Phase 2, modified by intravenous injections of 200 mgm. of pentothal in 5% solution mixed with 15 mgm. succinyl choline chloride.

Administration of the test

In the morning under resting and fasting conditions, the systolic blood pressure was taken by a nurse after the patient had been supine for at least 30 minutes. The recording was continued for a minimum of 5 minutes and usually 10 to 15 at half-minute intervals until 5 consecutive readings were within a range of 8 mm Hg. The mean of these last 5 readings was then taken as the basal blood pressure.

The doctor then injected intravenously† 0·025 or 0·05 mgm of l-adrenaline (synthetic), dissolved in 1 cc of distilled water. The blood pressure was recorded as frequently as possible for the first two minutes, not less than twice and usually four times a minute, and then twice a minute for a further five minutes. When the blood pressure had returned to the basal reading, 10 mgm. of mecholyl was given intramuscularly by the nurse. During this period the nurse took the blood pressure at minute intervals until 3 minute readings were within a range of 8 mm. Hg of the basal pressure. If the nurse could not obtain this level, a new basal level was obtained using the method outlined for the original basal.‡

Mecholyl injections were followed by intermittent recordings of pressure. These were taken

* "Mixed neurosis" embraces anxiety, phobic and obsessional states.

† Excessive rises of blood pressure following our initial dose of 0·05 mgm. adrenaline led us to substitute 0·025 mgm. We later learnt that this had been the experience and practice of FUNKENSTEIN and others.

‡ We were initially concerned about the possible diphasic hypotensive action of adrenaline (WHELAN, 1952) but preliminary tests during which we followed the blood pressure for 25 minutes showed us that while the majority returned to the original base-line an equal number remained slightly raised above or depressed below basal. We found a similar variability between basal pressures on different days in the same individual without apparent change in the clinical picture. Thus basal blood pressure remained a variable measure and justified, in our opinion, the use of two separate base lines on the same day if necessary.

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every half-minute for 7 minutes, every minute for the next 5 minutes, and then every 2 minutes until a total of 25 minutes had elapsed. If the patient had a chill or an emotional reaction (vide infra) the readings were continued except in three cases in which atropine had to be administered to check apparently dangerous parasympathetic overactivity.

Ninety-eight subjects were tested in this way.

Thirty-one subjects were also tested on separate days, with adrenaline on the first day and mecholyl on the second, or vice versa. These results are dealt with separately in this paper.

All testing and retesting was done not more than one week or less than 24 hours before the first E.C.T.

Anxiety or Chilling

Before the injection of adrenaline, we explained to the patient that temporary breathlessness or palpitation might ensue, but that this sensation would be transitory and harmless. Immediately after the injection we used a series of nondirective questions to elicit the presence of subjective anxiety, its degree and similarity to previous symptoms. Anxiety was judged to be present if the patient appeared to become more frightened, complained of anxiety or recognized the reactivation of previous anxiety symptoms. Similar criteria were used by the nurse following the mecholyl injection and recording.

Periods of rapid, involuntary, repetitive, generalized muscular contraction, associated with a sensation of marked cold, were regarded as chills when they occurred after mecholyl. Such chills occasionally occurred after adrenaline but were not scored. Blood-pressure readings were continued throughout these episodes and were quite readily obtained in most cases.

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Measures

In this paper we report the results obtained by dividing the data into the arbitrary groups described by FUNKENSTEIN (1949*a*; 1952).

(Eleven numerical measures for statistical analysis were also elaborated and these will be reported upon separately in other publications.)

Group 1.

Adrenaline: 0·05 mgm., rise in systolic pressure of 50 mm. Hg or more. 0·025 mgm., rise in systolic pressure of 40 mm. Hg or more.

Mecholyl: Slight fall in systolic pressure followed by a persistent rise of more than 5 mm. Hg from the basal, no fall followed by a persistent rise, or an immediate and persistent rise.*

Groups 2 *and* 3.

Adrenaline: as in Group 1.

Mecholyl: Moderate or slight fall in pressure with or without transitory rise above the basal line before a return to within 4 mm. Hg of the basal level for three consecutive minutes.

Group 4.

Adrenaline: As in Groups 1, 2, 3, etc.

Mecholyl: Mild or moderate fall, or no fall, followed by a sustained rise above the baseline, but with a subsequent return to within 4 mm Hg. within the 25 minute period; or immediate sustained rise, followed by later return to the baseline. That is, both Groups 1 and 4 show immediate or delayed hypertensive response but in Group 4 basal blood pressure is re-established within the test period.

* ALEXANDER (1955) also mentioned those who reacted by a rise following a very brief and slight fall, and it seemed to us also that these were best included in Group 1, with presumed sympathetic dominance. Where a brief and slight fall was unaccompanied by a subsequent rise we classified the subject in Group 2–3. In our experience total failure to react (GEOCARIS and KOOIKER, 1956) also occurred, but may have been due to the technical error of not recording the blood pressure frequently enough in the first few minutes, or to a failure of absorption from the site of injection, especially if it were not wholly intramuscular. Where this occurred in our cases they were classified as Group 2–3.

Group 5.

Adrenaline: 0·05 mgm., rise of less than 50 mm. Hg. 0·025 mgm., rise of less than 40 mm Hg.
Mecholyl: Moderate or marked fall of pressure with failure to return to within 4 mm of the baseline for three consecutive minutes within the 25 minute period.

Group 6.

Adrenaline: As Groups 1, 2, 3 and 4.
Mecholyl: As Group 5.

Group 7.

Included all patients suffering from a chill with mecholyl, excluding those showing anxiety after one or both drugs.*

Return to Basal Blood Pressure

Clearly where data are arbitrarily grouped in this manner, the criteria of return to basal pressure (or "homeostasis") are of great importance. From our data it seemed both impossible and misleading to express basal pressure as a single figure. It was a level fluctuating around a mean. We therefore decided that it was best expressed as the mean of consecutive readings within a range of 8 mm. Hg over a three minute period.

In some cases the blood pressure after returning to the baseline for the required time subsequently rose or fell. This obviously might lead to loss of information or misclassification with this method of grouping; such results are more fully taken into account by our alternative method of classification (to be published) and by that of FUNKENSTEIN in part, in which area measurements are made and examined statistically.

Diagnostic and Prognostic Criteria

Diagnosis: The diagnosis was that made by the senior physician in charge of the patient at the time of discharge or two months after the completion of treatment with ECT, if discharge had not taken place.

Outcome: was classified as follows:

Improved: Discharged from hospital within one month of termination of ECT without further physical treatment and not readmitted during the ensuing month.

Unimproved or Worse: Still in hospital one month after the completion of ECT and not clinically improved. Alternatively the patient might have returned to hospital within one month of discharge with recurrence of symptoms.

Results

The outcome (with treatment) in the various diagnostic groups is shown in Table 1 in the Appendix. The overall recovery rate was 55·9%.

The relation of outcome to blood pressure groups of all patients tested, whether by one or two day techniques and including those manifesting anxiety during the test is shown in Table 2; patients with inadequate adrenaline responses are also included in

* It has been remarked in earlier work (ALEXANDER, 1955) that chill prevents the taking blood pressure because of muscular noise, but that the curves are presumed to be always of a Group 6 type; (the suggestion is that some community of significance, if not of mechanism, occurs). In our series we were able to get tracings in all except those terminated with atropine. We found the responses scattered at random through the various groups, with the exception of Group 1. The two patients who had a Group 6 response failed to improve.

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this table. It can be seen that a greater proportion (51·4%) fall into Groups 2 and 3. The distribution resembles that found in a small group of 12 normal controls (Table 3). There were two in Group 1, seven in Groups 2 and 3, two in Group 4 and one in Group 5. But we have tested too few to establish what the normal distribution is in control subjects.

If all the "unfavourable" groups (1–5) are summed they can be compared with the "favourable" groups (6–7). In Table 4 it can be seen that outcome of treatment is independent of inclusion in a favourable or unfavourable group. Moreover it will be seen in Table 5 that membership in Group 2–3 goes with a favourable prognosis, but not at a statistically significant level in this series.

In order the more closely to compare our data with those of FUNKENSTEIN, we removed all subjects showing anxiety and inadequate adrenaline responses, and separated the results derived from the one day test from those of the two day test. The grouping by the former method can be seen in Table 6 and the latter in Table 7. There do not appear to be significant differences in the groupings or in their relationship to outcome with treatment. The number in the second group, the two day tests, is not sufficient to compare one and two day tests.

Significant differences cannot be obtained when the unfavourable groups (1–5) are compared with the favourable (6–7) in the one day series. (Table 8.) A similar situation is obvious in the two day series. (Table 9.)

Within the one day series membership of Group 2–3, as in the total series, is associated with a favourable prognosis, now at the 5% level of significance (Table 10). If adrenaline hyporeactors are included, but the anxiety and chill cases are still excluded, the results are again not significant.

Hyperpiesic Group

FUNKENSTEIN *et al.* (1952a) described a modification of the method suited to patients with a resting blood pressure of 140 mm. Hg or over. Our early experience of the profound hypotensive effect of mecholyl in this group discouraged us from testing them. We have the results of only a small number of such patients.

The Boston workers divided these patients into two groups on the basis of the blood pressure response to mecholyl alone. Group *A*, whose blood pressure failed to return to basal within the 25 minutes observation period, was found to respond well to E.C.T., Group *B*, those whose systolic pressure returned rapidly to basal following the injection were found to have an unfavourable response to this treatment.

Of our 12 patients, four were female and eight male, with an age range from 51 to 69 and a mean of 59·0. Ten were diagnosed as depressives and two as involutional psychotics. Four showed anxiety during the test. The outcome in relationship to Groups *A* and *B* is shown in Table 11 for all 12 cases, and in Table 12 for the eight cases who remain after those who responded with anxiety or chills have been removed. In keeping with our other results, there is no suggestion of a trend in the expected direction.

Anxiety and Chills

There were 26 patients who showed anxiety or chill reactions in response to the injections. The association of such reactions with response to treatment is shown in Table 13. The clear trends are in an unfavourable direction. Where anxiety is

evoked by adrenaline the outcome appears poor, especially so when reactions are also evoked by mecholyl. Mecholyl responses considered alone are towards improvement but there are insufficient cases to rule out a random distribution. When the group as a whole is matched with the remainder of the cases in the series prognosis is significantly worse at the 1 per cent level. (Table 14.)

Adrenaline Hyporeactors:

FUNKENSTEIN has always differentiated patients who had a low rise after adrenaline, in association with a prolonged mecholyl fall, from the favourable Group 6, and has given them a poor prognosis. There were less than 5% of these cases in the two series which FUNKENSTEIN published in 1952.

When all the adrenaline hyporeactors are considered together, including those who showed chill or anxiety in addition, there are 35 cases. It will be seen from Table 15 that there is a tendency towards a poor prognosis. Fourteen improved and twenty-one did not. This tendency runs through all of the arbitrary groups which are adequately represented, and there is a statistical difference when the group as a whole is compared with the remainder of the series at better than the one per cent level. This is still present after the removal of those patients who showed anxiety and chills (Table 16).

In only one area was the contention that Group 2–3 had a poor prognosis borne out. In Table 17 it will be seen that twelve of the patients in a total of 26 with anxiety and chills fell into Group 2–3 . Only two of these recovered with E.C.T.

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DISCUSSION

The blood pressure responses to adrenaline and mecholyl of these patients, when divided into groups, showed a similar distribution to that of a small series of normal subjects of our own and a similar small normal series of FUNKENSTEIN *et al.* (1949c). There are, however, too few controls to establish a normal distribution. The highest proportion of the patients fell into Groups 2–3 (57 of 111, or 51·4%) and this was associated with a somewhat better outcome with E.C.T. When this series was made to approximate as closely as possible to that of FUNKENSTEIN, this tendency to improve became significant at better than the 5% level. (Table 10.)

It would seem from this result that the less the disturbance of homeostasis and the quicker its restoration, i.e., the more the autonomic balance approximates to the presumed normal, the better the prognosis. Conversely the greater the disturbance the worse the outcome. This is the opposite of the findings not only of FUNKENSTEIN but also of ALEXANDER (1955). Such discrepancies and the fact that our results, although statistically significant were not highly so, leads us to caution in interpretation.

The method used in testing the majority of cases differed from that of FUNKENSTEIN *et al.* (1949a; 1952a) in that both adrenaline and mecholyl were given on the same day with a period for stabilisation of the blood pressure. However this method is now used by him with similar predictive value to the two day test (FUNKENSTEIN 1956). The results of our two day test, in so far as the small numbers permit comparison, do not appear to differ significantly from the one day results (Tables 7, 8, 9). However, in assessing the reliability of various methods of carrying out this autonomic testing we have findings which tend to cast doubt upon the suitability of the single day test. Test-retest correlations for the mathematical measures were lower than for

tests done on different days (SLOANE and LEWIS, to be published). Thus it is not inconceivable that by extending our two day test series to one hundred cases we might make findings more in accordance with those of FUNKENSTEIN. However there is no suggestion of this in the distribution of the present 31 cases tested on two days. A further series of mecholyl tests embarked upon by one of us (R. B. S.) at another institution has given even smaller numbers of Group 6 tests (4 in 50 cases.)

Possibly an important difference between our study and that of FUNKENSTEIN lay in the type of E.C.T. apparatus in use. All his patients received treatment by the Reiter machine, all ours by means of the Plexacon apparatus. However this is the machine most commonly used in this country and there is no reason to suppose that it is less or more efficacious than the other machine.

The presence of anxiety either in response to adrenaline or mecholyl, and of a chill, augured considerably against recovery especially if the anxiety followed both drugs. Taken as a group these patients showed less tendency to improve at the 0·01 level of significance. While this might be looked upon as a valuable new finding, it might be most easily explained as the response of a very anxious patient to any stressful incident. The finding may merely confirm the known clinical fact that patients with predominating anxiety do poorly with E.C.T.

Chilling occurred very rarely and we consider it of doubtful significance. We did not confirm that all cases of mecholyl chill have Group 6 curves to mecholyl (ALEXANDER, 1955). Our findings showed an even distribution through Groups 2–3, 4, 5 and 6.

In conclusion this study was designed to test the prognostic validity of blood pressure responses to adrenaline and mecholyl. (The method of arbitrary grouping or some similar one, whilst it may neglect available information, is requisite for ease of clinical application and interpretation.) Our results were discordant with those obtained by previous workers. Furthermore the distribution of the responses of these mentally ill patients resembled those of normal persons and chronic schizophrenics in the literature. (GEOCARIS and KOOIKER, 1956.) These findings raise doubts concerning the value of the procedure.

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SUMMARY

1. One hundred and eleven patients were tested before ECT by intravenous adrenaline and intramuscular mecholyl injections. Their systolic blood pressures and emotional responses were recorded.

2. The majority of these patients of mixed diagnosis, but with a preponderance of depression, showed the same range of responses as a small group of normal cases.

3. The use of a one day test and a two day test did not appear to give differing results, although we suspect that the one day method may prove unsatisfactory.

4. In the one day series, patients with response curves like those of normal controls showed the best prognosis. This is the opposite of previous reports.

5. Inadequate adrenaline responses and emotional responses were significantly associated with a poorer prognosis. Response was particularly poor where anxiety was precipitated by both drugs.

6. The finding by other workers that overaction to mecholyl (Group 6) was associated with a good prognosis was not confirmed. The number of cases in this group was so small as to cast doubt on the clinical value of this grouping system.

Acknowledgements—Our thanks are due to Professor AUBREY J. LEWIS for his advice and encouragement, to the doctors who allowed us to test their patients, to the nurses who participated in the study, and to the research committee of the Board of Governors of Bethlem Royal and the Maudsley Hospitals for financial assistance.

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APPENDIX

TABLE 1.—DIAGNOSIS AND RECOVERY

Diagnosis	Improved	Unimproved	Total
Depressives	37	22	59
Involutionals	5	3	8
Schizophrenics	4	8	12
Schizoaffectives	7	3	10
Neurotics	10	12	22
Total	63	48	111

TABLE 2.—ALL CASES. OUTCOME BY ARBITRARY GROUPS

Groups	Improved	Unimproved	Total
1	2	2	4
2 & 3	36	21	57
4	9	8	17
5	3	7	10
6	10	6	16
7	3	4	7
Total	63	48	111

TABLE 3.—GROUP DISTRIBUTION OF NORMAL CONTROLS.

Groups	No. of Cases
2	2
2–3	7
4	2
5	1
6	0
7	0
Total	12

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Table 4.—All cases. "Favourable" compared with "unfavourable" groups

Group	Improved	Unimproved	Total
1–5	50	38	88
6–7	13	10	23
Total	63	48	111

Chi squared = 0·0007 with 1 d.f. N.S.

Table 5. All cases. Group 2–3 compared with the remainder

Group	Improved	Unimproved	Total
2–3	36	21	57
Remainder	27	27	54
Total	63	48	111

Chi squared = 1·953 N.S.

Table 6.—One day series. Patients showing anxiety, chills and inadequate adrenaline responses have been removed

Group	Improved	Unimproved	Total
1	1	1	2
2–3	27	6	33
4	4	0	4
5	3	6	9
6	6	5	11
7	2	1	3
Total	43	19	62

TABLE 7.—TWO DAY SERIES. PATIENTS WITH ANXIETY AND CHILLS AND INADEQUATE ADRENALINE RESPONSES REMOVED

Group	Improved	Unimproved	Total
1	3	0	3
2–3	2	3	5
4	2	2	4
5	0	1	1
6	1	1	2
7	0	0	0
Total	8	7	15

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TABLE 8.—ONE DAY SERIES. "FAVOURABLE" GROUPS, 6–7, COMPARED "UNFAVOURABLE" GROUPS, 1–5

Group	Improved	Unimproved	Total
1–5	35	13	48
6–7	8	6	14
Total	43	19	62

Chi squared = 1·40 with one degree of freedom. Not significant.

TABLE 9.—TWO DAY TESTS. "FAVOURABLE" GROUPS 6–7 COMPARED WITH "UNFAVOURABLE" GROUPS 1–5

Group	Improved	Unimproved	Total
1–5	7	6	13
6–7	1	1	2
Total	8	7	15

Table 10.—One day series. Cases in the "normal" responsive group against the remainder, exclusive of those with anxiety responses, chills and inadequate adrenaline responses.

Group	Improved	Unimproved	Total
2–3	27	6	33
Others	16	13	29
Total	43	19	62

Chi squared = 5·16 with one degree of freedom $0{\cdot}05 < p < 0{\cdot}01$

Table 11.—Hypertensive series: groups and outcome.

Group	Improved	Unimproved	Total
A	4	5	9
B	3	0	3
Total	7	5	12

Table 12.—Hypertensive series: groups and outcome.

Group	Improved	Unimproved	Total
A	3	3	6
B	2	0	2
Total	5	3	8

TABLE 13.—ANXIETY AND CHILL RESPONSES, AND OUTCOME

Response	Improved	Unimproved	Total
Mecholyl Chill	2	1	1
Mecholyl Anxiety	4	2	6
Adrenaline Anxiety	2	6	8
Adr. Anx., Mech. Anxiety.	0	5	5
Adr. and Mech. Anx., Mech. Chill.	0	2	2
Adr. Anx., Mech, Chill.	1	1	2
Total	9	17	26

TABLE 14.—ANXIETY AND CHILL RESPONSES. OUTCOME COMPARED WITH REMAINDER

Group	Improved	Unimproved	Total
Anxiety and Chills	9	17	26
Others	54	31	85
Total	63	48	111

Chi squared = 6·995 with one degree of freedom. $P < 0{\cdot}01$.

TABLE 15.—ADRENALINE HYPOREACTORS. ARBITRARY GROUPS AND OUTCOME

Group	Improved	Unimproved	Total
1	0	0	0
2–3	8	11	19
4	2	4	6
5	3	6	9
6	—	—	—
7	1	0	1
Total	14	21	35

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TABLE 16.—ADRENALINE HYPOREACTORS (INCLUDING THOSE WITH ANXIETY RESPONSES) AGAINST REMAINDER.

Group	Improved	Unimproved	Total
Hyporeactors	14	21	35
Remainder	49	27	76
Total	63	48	111

Chi squared = 7·787 with one degree of freedom. $P < 0.01$.

TABLE 17.—ANXIETY AND CHILL CASES SCORED BY ARBITRARY GROUPS ONLY.

Group	Improved	Unimproved	Total
1	0	1	1
2–3	2	10	12
4	5	3	8
5	1	2	2
6	1	1	2
7	—	—	—
Total	9	17	26

Journal of Psychosomatic Research, 1956, Vol. 1, pp. 287 to 291. Pergamon Press Ltd., London

LIFE SITUATIONS, BEHAVIOUR, ATTITUDES, EMOTIONS, AND RENAL EXCRETION OF FLUID AND ELECTROLYTES*—IV†

SITUATIONS ASSOCIATED WITH RETENTION OF WATER, SODIUM, AND POTASSIUM

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IN previous reports (SCHOTTSTAEDT, GRACE, and WOLFF, 1956a,b,c), situations, behaviour patterns, attitudes, and feeling states were described which were associated with retention of water and sodium or with varying patterns of diuresis of water, sodium, and potassium. Some reactions to stimuli perceived as hazardous were accompanied by restrained behaviour, feelings of increased alertness, and retention of water and sodium; whereas sudden release from such threats was associated with a diuresis of water (SCHOTTSTAEDT *et al.*, 1956b). Other reactions were associated with a diuresis of both water and sodium (SCHOTTSTAEDT *et al.*, 1956c). In this report, situations and reaction patterns are described which were associated with retention of water, sodium, and potassium. Details of this method and of variations in renal excretion observed in association with variations in intake and activity have been presented in a previous paper (SCHOTTSTAEDT *et al.*, 1956a). Rates of excretion recorded here are average rates for periods of four to six hours.

RESULTS

Retention of water, sodium, and potassium was observed in association with situations that elicited behaviour characterized by reduced activity and slow speech, attitudes of hopelessness or futility, and feelings of depression, loneliness, or exhaustion. This reaction pattern will be referred to as pattern *C*. A summary of excretion rates observed under these circumstances is given in Table 1.

Subject #1 was a housewife who obtained considerable satisfaction from productive activity. Friends suggested she attend a tailoring class with them one evening. They were enthusiastic, and she attended with high expectations. Unfortunately, the class was unattractive to her. She considered it unorganized and holding no promise of interest for her. She had no desire to participate further, and did not return for subsequent classes. However, she tried to be active and to appear interested during the evening she was there, despite her feelings of disappointment and depression. Excretion rates during this period were 0·49 cc/min for water, 62 μeq/min for sodium, and 33 μeq/min for potassium (Table 2).

This subject enjoyed a close relationship with her family and friends. However, during the period of observation she was living at a considerable distance from them. When one of her cousins was to be married, many of her relatives gathered in a neighbouring town for the wedding. She felt

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†Part IV represents the fourth of a series of five papers which have been published consecutively. Part V follows on p. 292, in this issue.

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TABLE 1.—COMPARISON OF RENAL EXCRETION DURING NEUTRAL PERIODS AND DURING SITUATIONS EVOKING REACTION PATTERN *C*

Pattern	Subject	No. of observations	5-hour excretion			
			H_2O (cc/min)	Na (μeq/min)	K (μeq/min)	
					day	night
Neutral	#1	47	0·76	96	54	23
	#2	32	0·67	97	56	29
	#3	13	0·83	85	37	23
	#4	16	0·69	100	60	35
	#5	11	1·18	246	80	49
Pattern *C*	#1	23	0·49	53	48	20
	#2	8	0·49	56	41	28
	#3	4	0·48	37	—	21
	#4	7	0·47	69	54	39
	#5	1	0·67	109	58	—

"depressed" at being unable to attend part of the festivities, and spent one evening sitting quietly at home wishing she might be with them. Renal excretion rates during this period of reduced activity and feelings of depression are recorded in Table 2.

She awakened one morning feeling tired, depressed, and exhausted, despite a good night's rest. She found it difficult to do the usual morning's work, though she accomplished the tasks which were required of her. Excretion rates during this morning of reduced activity and feelings of futility, depression, and exhaustion were 0·48 cc/min for water, 34 μeq/min for sodium, and 51 μeq/min for potassium.

On another occasion she spent one entire day in vigorous muscular work, doing the autumn housecleaning in addition to her regular activities of child-care. At the end of the day, she felt physically exhausted. Excretion rates during the subsequent evening hours, spent in writing letters, were 0·45 cc/min for water, 33 μeq/min for sodium, and 94 μeq/min for potassium.

These last two examples illustrate decreases of similar degree in the excretion of water and sodium during situations characterized by feelings of exhaustion, whether the urine collection period came at the end of a day of exhausting physical activity or during the morning hours after a night of rest.

Subject #2 was a medical resident who was carrying on a research project in addition to his other duties. He found specimens accumulating faster than the laboratory could handle them. One Saturday afternoon, after a difficult week which had included much night work, he found it necessary to work in the laboratory. During this afternoon he felt physically exhausted and emotionally depleted. However, he went about his work with diligence and concentration. Renal excretion rates during this afternoon period of observation were 0·48 cc/min for water, 50 μeq/min for sodium, and 33 μeq/min for potassium.

Subject #3 had been referred to us because of attacks of "uncontrollable rage." She frequently felt depressed after these outbursts. On one occasion she had a mild disagreement with her landlord, which ended when she kicked him in the shins. She did not see him again until some weeks later, when she went to pay her rent. During the hours prior to this meeting with her landlord, she reported that she felt both "tense" and "depressed" as she recalled her previous behaviour and considered what she should say to make amends. Renal excretion rates during this time were 0·27 cc/min for water, 28 μeq/min for sodium, and 15 μeq/min for potassium. This is a marked decrease from the average renal excretion rates observed in this subject during neutral periods: 0·83 cc/min for water, 85 μeq/min for sodium, and 37 μeq/min for potassium.

TABLE 2.—RENAL EXCRETION OF WATER, SODIUM, AND POTASSIUM IN ASSOCIATION WITH PATTERN *C*

Subject	Time	Situation	5-hour excretion H_2O (cc/min)	Na (μeq/min)	K (μeq/min)	5-hour intake H_2O (cc)	Na (meq)	K (meq)
#1	a.m.	Light housework after exhausting day	0·48	34	51	150	13	3
		Felt "left out" and depressed	0·44	25	24	150	6	6
		Seeing friend off on plane—depressed	0·37	34	26	500	13	11
		Everyone departed—depressed	0·35	19	41	300	41	8
		Tired on awakening—tense and depressed	0·46	34	19	300	4	3
	aft.	Felt "left out" and depressed	0·68	32	63	450	21	18
		Letter-writing—tired and depressed	0·77	44	52	150	18	4
		Everyone departed—depressed	0·30	58	69	300	41	8
	evg.	Felt "left out" and depressed	0·60	39	60	450	63	24
		Disappointed with tailoring class	0·49	62	33	250	65	24
		Quiet evening after exhausting day	0·45	33	94	1150	66	59
		Worn out by day's activities	0·50	29	47	1150	75	42
		Drove friends to train—tense and depressed	0·46	78	43	750	41	54
		Quiet evening after tiring day	0·38	47	45	500	52	37
	night	Felt "left out" and depressed	0·82	48	31	0	0	0
		Tired and depressed on retiring and arising	0·48	78	24	0	0	0
		Sleeping after tiring day	0·46	73	20	0	0	0
		To bed exhausted; tired on awakening	0·47	78	19	0	0	0
		"Tired" on retiring and awakening	0·58	69	16	0	0	0
		To bed early, "worn out"	0·47	88	11	0	0	0
		Tense and tired on retiring	0·36	66	20	0	0	0
		Tired on retiring and awakening	0·51	82	25	0	0	0
		After disappointing tailoring class	0·42	67	15	250	8	10
#2	a.m.	Had to abandon experiment—depressed	0·70	83	63	500	13	12
	aft.	Tired. Three depressing interviews	0·60	91	22	970	53	21
		Depressed at spending Saturday afternoon in laboratory	0·48	50	33	730	26	21
		Depressed with progress of experiments	0·43	32	38	640	72	22
	evg.	Depressed with progress of experiments	0·47	48	41	640	61	19
		Feeling exhausted after full day	0·47	69	55	700	68	44
		Tired after depressing day	0·40	45	46	1000	46	66
	night	Depressed with progress of experiments	0·35	32	28	0	0	0
#3	night	Considering suicide	0·47	45	28	Incomplete		
		Depressed by her own actions	0·57	49	18			
		Sleeping following confession	0·63	28	22			
		Night before rent due	0·27	28	15			
#4	aft.	Everyone ill; tense and depressed	0·40	27	64	300	57	12
	evg.	Tired at end of hard week	0·44	98	50	390	90	21
		Tired after busy day	0·46	64	48	150	75	26
	night	Feeling "exhausted" on retiring	0·57	57	36	480	19	11
		Tired and depressed on retiring and awakening	0·35	58	37	480	14	14
		Tense and depressed at bedtime; tired on awakening	0·59	78	35	240	19	11
		Tired on retiring and awakening	0·48	76	28	0	0	0
#5	evg.	Depressed by discussion with friends	0·67	109	58	480	55	19

TABLE 3.—RENAL EXCRETION OF WATER, SODIUM, AND POTASSIUM WITH MISCELLANEOUS STATES

Subject	Time	Situation	Pattern	5-hour excretion H_2O (cc/min)	Na (μeq/min)	K (μeq/min)	5-hour intake H_2O (cc)	Na (meq)	K (meq)
#1	evg.	Depressed. Irritable with children	*B′* and *C*	0·59	101	41	650	79	47
		Depressed. Children very noisy							
	night	Depressed and irritated on retiring	*B′* and *C*	0·89	95	91	550	56	23
			B′ and *C*	0·60	103	24	0	0	0
	aft.	Relatives leaving; depressed and let-down	*A′* and *C*	1·13	56	53	300	29	14
	a.m.	Defending husband to neighbours	Unclassified	1·79	132	46	300	7	3
	aft.	After defending husband to neighbours	Unclassified	0·80	134	27	300	21	17
	night	Following an evening of confusion	Unclassified	0·76	59	32	0	0	0
#2	a.m.	Depressed and irritated with experiments	*B′* and *C*	0·58	83	64	500	13	12
		Mixed feelings on starting new experiments	Unclassified	1·15	42	52	500	8	5
		Doing experiment on self	Unclassified	0·52	93	58	0	0	0
	night	Disappointed and "let-down" during evening	*A′* and *C*	0·82	41	51	300	0	0
#3	a.m.	Disappointed with boy friend	*A′* and *C*	1·00	74	33	Incomplete		
		Discussion with sister of boy friend	*A′* and *C*	1·08	95	38			
	aft.	"Worried" about boy friend	Unclassified	0·68	125	39			
	evg.	Confession to priest	*A′* and *C*	1·23	69	19			
		Boy friend arrived	Unclassified	2·15	45	26			
		Dinner with "friend"	Unclassified	1·12	154	17			
	night	Restless night	Unclassified	1·10	34	23			
		Vomiting during night	Unclassified	0·47	61	22			
		After awaiting boy friend who did not arrive	*A′* and *C*	1·41	53	19			
#4	aft.	Quiet but feeling "ill"—nasal congestion	Unclassified	2·50	251	118	490	83	33
		Mixed feelings at change in plans	Unclassified	2·20	212	93	370	77	21
		Quiet; headache subsiding	Unclassified	0·88	203	85	350	68	13
#5	a.m.	"Heavy-headed." Stimulating work	Unclassified	1·00	210	72	60	0	3
		Vague bitemporal discomfort	Unclassified	0·79	168	56	720	119	18
		Subsiding headache	Unclassified	1·25	270	90	1020	51	20
	evg.	"Heavy-headed." Tense at work	Unclassified	0·63	117	66	420	86	6

When reaction pattern *C* was sufficiently prolonged, weight-gains were noted by the subjects of these experiments. One subject reported a weight-gain of eight pounds in association with a prolonged period of concentrated effort which appeared to him to be unproductive and unrewarding. He reported feelings of "tension" and "depression" during this period. When the sources of "tension" were removed and he felt relatively relaxed and at ease, he lost most of this weight in a period of forty-eight hours, during which he had a major diuresis of fluid.

Reaction patterns were often mixed and complex, and a variety of renal excretion patterns accompanied these. Some were too complex for clear interpretation, while others seemed to be combinations of the various patterns already presented (Table 3). Thus, when situations aroused behaviour, attitudes, and emotions characteristic of pattern *B*, which was associated with a diuresis of water and sodium, concurrently

with behaviour, attitudes, and emotions characteristic of pattern *C*, which was associated with retention of water and sodium, renal excretion rates were intermediate between these two patterns. Similarly, when situations aroused reaction pattern *A'* (characterized by physical relaxation, feelings of "freedom from tension", and a water diuresis) concurrently with reaction pattern *C* (characterized by reduced activity, feelings of futility, depression, or exhaustion, and decreased excretion of fluid and electrolytes), renal excretion rates combined features of both patterns.

DISCUSSION

A decrease in the rates of excretion of water, sodium, and potassium was observed in the subjects of these experiments in association with situations arousing reactions characterized by reduced physical activity, attitudes of dejection or hopelessness, and feelings of depression or exhaustion. When sufficiently prolonged, this reaction pattern was associated with weight gain. Though the weight-gains recorded during these observations were not of major proportions, they could be of considerable significance to a patient with cardiovascular disease in borderline compensation. Of interest in this regard are the findings of CHAMBERS and REISER (1953). These authors presented correlations of stressful life situations, emotional reactions, and the onset of congestive failure. Two types of environmental situations and emotional responses were reported to be of special importance: (1) episodes arousing rage and frustration, and (2) episodes arousing feelings of rejection and loss of security. They described their first patient as "seriously depressed," and mentioned "tension" in a number of others. Should patients with cardiovascular disease show the same correlation of stressful life situations and feelings of "tension" and "depression" with retention of water and sodium which we have noted in the healthy subjects of the present experiments, then congestive failure might follow on the basis of renal retention of fluid and electrolyte.

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CONCLUSIONS

1. In the five subjects of these experiments, forty-three situations evoking reactions characterized by reduced physical activity, attitudes of futility or hopelessness, and feelings of depression or exhaustion (pattern *C*) were associated with decreased rates of excretion of water, sodium, and potassium as compared with excretion rates observed during neutral and tranquil periods.

2. In these subjects, situations arousing complex reactions combining features of two or more of the patterns described were associated with excretion rates which seemed also to combine features observed with each reaction pattern.

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Journal of Psychosomatic Research, 1956, Vol. 1, pp. 292 to 298. Pergamon Press Ltd., London

LIFE SITUATIONS, BEHAVIOUR, ATTITUDES, EMOTIONS, AND RENAL EXCRETION OF FLUID AND ELECTROLYTES*—V

VARIATIONS IN EXCRETION OF ENDOGENOUS CREATININE

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ENDOGENOUS creatinine clearance has been commonly used as a clinical indicator of glomerular filtration rate (MILLER and WINKLER, 1938; STEINITZ and TURKAND, 1940; MILLER *et al.*, 1952; BROD and SIROTA, 1948; SCHOCH and CAMARRA, 1952) though it has been reported to be unreliable in the presence of renal disease (MILLER and WINKLER, 1940; MILLER *et al.*, 1952). The effect of protein consumption on the rate of creatinine excretion has been intensively studied. FOLIN (1905), in his original work on mentally ill patients, used a meat-free diet and found creatinine excretion constant. ZWARENSTEIN (1926), however, reported major variations in his subjects who were also on a meat-free diet. HOBSON (1939), studying men at a physical training college, reported variations in urinary creatinine excretion ranging from 1·43 to 3·80 g/day on a diet of "adequate animal protein" with no significant variation in creatinine excretion when this was changed to a high protein intake. BEST *et al.* (1952) reported variations in creatinine excretion from 1·64 to 2·01 g/day when subjects maintained their "usual" diets. ADDIS *et al.* (1951) found only minimal increases in urinary creatinine when protein intake was increased fivefold (from 0·5 to 2·5 g/kg). SCHOCH and CAMARRA (1952), however, state that in using creatinine clearance as a test of glomerular filtration rate, the subject should be kept on a low protein diet with no more than 60 g of meat daily. In contrast to these divergent reports on urine creatinine, serum creatinine has been found to be constant by most investigators (BROD and SIROTA, 1948; SCHOCH and CAMARRA, 1952; ADDIS *et al.*, 1951; SIROTA *et al.*, 1950).

In studies of diurnal variation in creatinine excretion, SIMPSON (1924) and ADDIS (1951) found a decrease in creatinine excretion at night. SIROTA, BALDWIN, and VILLARREAL (1950), and STANBURY and THOMSON (1951) also reported a fall in nocturnal excretion of creatinine, but found it to be small and unpredictable.

Fluctuations in creatinine excretion or glomerular filtration rate in association with changing emotions and feeling states have been little studied. BROD and SIROTA (1949) have reported a decrease in renal blood-flow and glomerular filtration rate (PAH and Cr) in rabbits accompanying the antidiuresis consequent on "emotional disturbance" or noxious stimulation. PFEIFFER and WOLFF (1950) reported minor decreases in filtration rate in man associated with discussion of topics known to have threatening significance. And recently, MILES *et al.* (1952) have reported the case of a

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hypertensive woman who showed a marked diuresis accompanying an emotional reaction to cystoscopy with an increase in filtration rate which they concluded to be due to renal vasodilatation.

The present studies were undertaken to ascertain whether variations in the excretion of water, sodium, and potassium did indeed occur in association with changing emotions and feeling states. The results of these experiments are of significance despite the lack of serum creatinine determinations and the consequent inability to translate excretion rates into specific filtration rates.

METHOD

Details of the procedure used in these experiments have been given in a previous report (SCHOTTSTAEDT *et al.*, 1956a). Urine specimens were collected at 0700, 1200, 1700 and 2200 while the subjects went about their usual daily routines. Creatinine chromogen was determined on duplicate samples of urine by a modification of the method of BONSNES and TAUSSKY (1945). These determinations were made for eighteen consecutive days on Subject #1, seven days on Subject #2, and throughout the eighteen- and fourteen-day observation periods on Subjects #4 and #5 respectively. This totalled fifty-seven days and 228 determinations. Meat intake was estimated from dietary records, using the tables of *Bridges' Food and Beverage Analyses* edited by MATTICE and published in 1950.

RESULTS

Variations in 24-hour excretion. The variations observed in 24-h output of creatinine are presented in Table 1. Average creatinine excretion varied from 1·39 g/day in Subject #1 to 2·21 g/day in Subject #5. The ranges of output for any one subject also varied strikingly: from 77 to 121% of the mean in Subject #1, from

TABLE 1.—URINARY CREATININE EXCRETION IN GRAMS FOR 24 HOURS

Day	Subject #1	Subject #2	Subject #4	Subject #5
1	1·37	1·62	2·68	1·90
2	1·29	1·64	2·06	2·10
3	1·39	1·60	2·01	2·30
4	1·48	1·46	2·27	1·63
5	1·41	1·94	2·39	2·42
6	1·34	1·73	1·97	2·23
7	1·30	1·69	1·69	2·62
8	1·08		2·01	2·15
9	1·28		1·78	2·09
10	1·29		1·98	1·96
11	1·27		1·33	2·33
12	1·36		1·47	2·20
13	1·42		1·66	2·55
14	1·57		1·55	2·42
15	1·50		2·05	
16	1·46		2·11	
17	1·53		1·87	
18	1·69		1·86	
Average	1·39	1·67	1·93	2·21
Range	1·08	1·46	1·33	1·63
	1·69	1·94	2·68	2·62

88 to 116% of the mean in Subject #2, from 69 to 139% of the mean in Subject #4, and from 74 to 119% of the mean in Subject #5. These fluctuations from −31 to +39% are similar to the variations from −20 to +23% reported by BEST *et al.* (1952). Examination of the sequence of figures shows that either high or low excretion rates occurred in isolation or continued for several days in succession.

Relation of 24-hour creatinine output to meat consumption. The variations noted in creatinine excretion showed little correlation with meat consumption. This indicates that some factor other than meat intake is in operation in determining these variations (Table 2). Subject #1 exhibited no appreciable difference in meat consumption on

TABLE 2.—RELATION OF CREATININE EXCRETION TO MEAT CONSUMPTION

Subject	Average meat intake g/day when Cr excretion was—		Range of meat intake g/day when Cr excretion was—	
	Below average	Above average	Below average	Above average
#1	94	91	10–180	50–145
#2	154	220	115–200	215–230
#4	115	113	40–215	20–230
#5	220	152	130–370	50–330
Average for four subjects	146	144		

those days when creatinine excretion was below average output as compared with days when her creatinine excretion was above average. Both lowest and highest intake levels were associated with *low* creatinine excretion. In contrast, in Subject #4 both lowest and highest meat intake were associated with *high* creatinine excretion. Subject #2 showed a good correlation of meat consumption with creatinine excretion; that is, high intakes were associated with high outputs. Subject #5, however, showed a higher meat consumption on days of low creatinine excretion than on days of high excretion (220 g with low output as compared to 154 g with high output). When all of the average intakes are combined, no difference in meat intake can be demonstrated for days of low creatinine excretion as compared with days of high excretion, despite the fact that daily meat intake varied from 10 g to 370 g.

Diurnal variation in creatinine excretion. Average excretion rates of creatinine for each subject are given in Table 3 according to time of day. Creatinine excretion in Subjects #1 and #2 decreased during the night as compared with morning excretion. Subject #4 showed no significant difference between night and morning excretion rates. Subject #5 had a higher excretion rate at night. The night-to morning ratios were 0·94, 0·91, 0·99, 1·19 respectively. When combined, these excretion rates showed no significant difference in night and morning excretion of creatinine. This is in conformity with the reports of SIROTA, BALDWIN, and VILLARREAL (1950). All four of the subjects studied in this investigation showed an evening maximum.

Though there was relatively little variation in the average excretion rates for different periods of the day in any one individual, the ranges of excretion within each period were very great. Thus in Subject #1 the highest rate of excretion during any

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TABLE 3.—DIURNAL VARIATION IN URINARY CREATININE EXCRETION IN MGM/MIN

Subject	Averages (mg/min)			
	Morning	Afternoon	Evening	Night
#1	1·01	1·05	1·06	0·94
#2	1·20	1·14	1·27	1·09
#4	1·26	1·34	1·40	1·25
#5	1·31	1·43	1·73	1·57
Combined average	1·20	1·24	1·36	1·21
	Ranges (mg/min)			
#1	0·71–1·35	0·89–1·71	0·73–1·36	0·83–1·22
#2	0·99–1·37	1·01–1·27	1·10–1·47	0·97–1·23
#4	0·86–1·84	0·92–2·63	0·98–2·21	0·78–1·57
#5	1·04–1·93	0·82–1·81	0·85–2·49	1·15–1·87

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period of the day was almost 100% greater than the lowest rate of excretion during the same period of the day. In Subject #4 the highest afternoon excretion was 285% greater than the lowest afternoon excretion: 2·63 mg/min as compared with 0·92 mg/min.

If this variation were due to inadequate emptying of the bladder, one would expect an "overshoot" in creatinine excretion in the subsequent specimen. This did not occur. For example, in Subject #4 the afternoon low of 0·92 mg/min was preceded by low excretion and followed by low excretion rates for more than twenty-four hours, at which time the level of excretion returned to mean values, but did not exceed them. Similarly, in the same subject, the high afternoon rate of 2·63 mg/min was preceded and followed by similarly high rates of creatinine excretion. Nor is the difference due to variation in meat consumption: on both days there had been no meat taken at breakfast and only 20 to 25 g of meat at lunch.

Variations in association with changing behaviour, emotions, and feeling states. In order to compare creatinine excretion rates observed in association with situations arousing a variety of emotions and feeling states in subjects with different ranges of excretion, all rates were converted to percentages of the mean rate observed during neutral periods. A neutral period was one in which the individual was effectively performing routine duties in a familiar setting, neither disturbed by nor aware of threatening stimuli or unusual demands. Examples of such periods have been given for each subject (SCHOTTSTAEDT *et al.*, 1956b). Creatinine excretion rates for these neutral periods were averaged for each individual, and this mean was given the value 100%. The standard deviation of the neutral periods was $\pm$1·9 (Table 4).

In previous papers SCHOTTSTAEDT *et al.*, 1956b,c,) decreased rates of excretion of water and sodium were reported in association with situations arousing restrained but alert behaviour and feelings of tension (pattern *A*) or reduced activity and feelings of

TABLE 4.—COMPARISON OF URINARY CREATININE EXCRETION DURING NEUTRAL PERIODS WITH VARIOUS REACTION PATTERNS

Reaction pattern	Number of observations	Mean	S.D. Mean	*P*
Neutral	51	100	±1·9	—
Pattern *A*	60	84·8	±1·9	<0·001
Pattern *A′*	14	99·5	±3·6	N.S.
Pattern *B* and *B′*	38	110·4	±3·2	<0·01
Pattern *C*	18	90·4	±2·2	<0·01

depression or exhaustion (pattern *C*). The decrease in fluid and electrolyte excretion was of comparable magnitude in association with these two reaction patterns. Table 4 gives the average excretion rates of creatinine under these same circumstances. Situations arousing restrained but alert behaviour and feelings of tension were accompanied by rates of creatinine excretion which averaged 15% below the mean observed during neutral periods. This decrease was highly significant (*P* less than 0·001)

A significant decrease in excretion rates of creatinine was observed in association with situations arousing reaction pattern *C*, characterized by reduced activity and feelings of depression, fatigue, or exhaustion. Feelings of tension were not infrequently associated with these feelings of depression and exhaustion during such situations. Creatinine excretion during eighteen such observation periods showed an average decrease of 9·6% below the rate observed during neutral and tranquil periods ($P < 0·01$).

As a corollary to the decreased rates of creatinine excretion observed in association with situations arousing restrained, alert behaviour and feelings of tension, one might anticipate an increased rate of creatinine excretion during periods characterized by sudden "freedom from tension," that is during periods in which threats or demands were lessened or removed and the individual relaxed and felt at ease again (pattern *A′*). This did not occur. Situations arousing feelings of "freedom from tension" were associated with rates of creatinine excretion similar to those observed during neutral periods (Table 4), though the excretion of water was markedly increased (SCHOTTSTAEDT *et al.*, 1956c.)

Significant increases in excretion rates of creatinine were observed in association with situations arousing reaction patterns *B* and *B′* (Table 4). These reaction patterns were generally characterized by restless behaviour and feelings of apprehension, excitement, or anger accompanied by increased excretion of fluid and electrolytes. Creatinine excretion during thirty-eight such observation periods showed an average increase of 10·4% above the rate observed during neutral and tranquil periods ($P < 0·01$).

DISCUSSION

A significant decrease in the rate of urinary excretion of endogenous creatinine has been demonstrated in association with situations arousing reaction patterns *A* and *C* in the subjects of these experiments. That this decrease was not due to bladder

retention consequent on inadequate voiding was evidenced by the failure of the rate of creatinine excretion to rise above average levels in subsequent periods.

An increase in the rate of creatinine excretion was observed in association with situations arousing reaction patterns on *B* and *B'*. This was accompanied by a diuresis of water and sodium. It is probably not dissimilar to the state reported in a hypertensive woman by MILES *et al.* (1952). These investigators reported an increase in glomerular filtration rate as measured by inulin clearance.

Though the exact meaning of the variations in rate of urinary creatinine excretion observed in the present series of investigations cannot be given without clearance studies, it is evident that creatinine excretion alone cannot be used as an accurate index of bladder emptying when the behaviour and emotional state of the subject is changing.

CONCLUSIONS

In these studies:

(1) 24-hour creatinine excretion varied from −31 to +39% of the mean in a single individual.

(2) 24-hour creatinine excretion bore no constant relationship to meat consumption.

(3) Night and morning excretion rates of creatinine showed no significant difference in the pooled data.

(4) Marked variations in rate of creatinine excretion were observed during all periods of the day.

(5) Situations evoking reaction pattern *A*, characterized by restrained, alert behaviour and feelings of tension and decreased excretion of water and sodium, were accompanied by a significant decrease in the rate of creatinine excretion.

(6) Situations evoking reaction patterns *B* and *B'*, characterized by restless behaviour, feelings of apprehension, excitement, or anger, and increased excretion of fluid and electrolytes, were associated with a significant increase in creatinine excretion.

(7) Situations evoking reaction pattern *C*, characterized by reduced activity, feelings of depression or exhaustion and decreased excretion of water, sodium, and potassium, were associated with a significant decrease in creatinine excretion.

(8) Situations evoking reaction pattern *A'*, characterized by relaxation and freedom from previously existent tension accompanied by a water diuresis, were not associated with significant variations in creatinine excretion.

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BOOK REVIEWS

La Médecine Psychosomatique PAUL CHAUCHARD. Collection "Que Sais-je?" Presses Universitaires de France.

THIS small book from the well-known popular collection "Que sais-je?" is an introduction to the subject of psychosomatic medicine and an attempt to assess its present status. The book is divided into three parts: the first deals with the mechanisms in charge of maintaining psychosomatic health; the second considers how this equilibrium can be interfered with by illness; the third considers therapeutic methods. Let it be said immediately that the third part, though systematically dealt with, can only be incomplete and superficial, as it naturally cannot be technical or practical.

Apart from well-known facts (the literature is generously international and the book is dedicated to the Russian physiologist BYKOV), some aspects of this survey should interest the Anglo-American reader who seldom has access to certain continental views. For instance, the remarkable studies of REILLY on the role of the autonomic nervous system in stress, with special reference to differences of function of this system in health and when damaged; or the role of chronaxie in regulation of function, a subject which has been particularly developed by the French, especially such aspects as "chronaxie de subordination." Dr. CHAUCHARD is himself an expert on the subject of neurophysiology, and his treatment of the role of the nervous system in the regulation and harmonization of function is perhaps the most interesting part of the book. Conditioned reflexes, with special reference to vegetative function, are given much attention. The author is concerned with the neurophysiological mechanisms that he considers give scientific credence to certain Freudian findings. Thus, he writes "there still remains the task of constructing a true psychosomatic medicine which will rest on the recent progress of neurophysiology which has come to demonstrate the part of truth contained in the Freudian theory and to make more precise the mechanisms responsible for these disturbances, thus giving birth to new therapies." He is unitarian and opposed to the old dualism. Psychoanalysis plays an important and even central part in this programme, but no impression is created that the author (though sympathetic) has a deep understanding of it.

HENRI REY

PEDRO L. ENTRALGO: **Mind and Body**. London, Harvill. 1955. Pp. 150. 12s. 6d.

IN this critical review of the evolution of medical thought on psychosomatic pathology Professor ENTRALGO has succeeded in providing an erudite, but most readable, historical survey. He begins by considering the concepts of disease held by the early Assyro-Babylonian culture. The peoples of the Semitic Orient elaborated a highly personalistic religious conception of disease in which a patient was regarded as sick because he had been a sinner. This attitude is contrasted with that of the Hellenic culture which regarded sickness not as a moral but as a physical blemish, disease being a disorder in the nature of the patient. Whilst the Semitic approach was too personalistic to have been the starting point of a psychosomatic pathology, the Greek attitude suffered from the opposite defect of an excessive "naturalism." Although Hippocratic and Galenic medicine developed into modern physiology, Greek medicine eventually viewed the sinner as a sick man and arrogated the control of his moral life.

It was left to primitive Christian medicine to resolve the opposition between Semitic personalism and Greek naturalism. By teaching that there was a basic difference between sin and disease and recognizing their possible secondary interrelationship, Christianity made possible, though not actual, a genuine psychosomatic pathology.

Though medicine has always been more or less psychosomatic, only in our times has a pathology come into existence which fully deserves the title. For although the clinical therapist has always observed and treated real men and women, often noting the effect of the emotions on the course of the disease, a Cartesian attitude has always been implicit. Man has been regarded as a *res cogitans*,

spiritual and free, and a *res extensa* made up of the solid parts and the humours. Although the former may be invoked in the approach to the patient, it is the latter which has in the past invested pathology with its mechanistic naturalism, rooted in visual and tactile knowledge.

ENTRALGO considers that, thanks to the work of FREUD, western pathology by being not only visual and tactile, but also auditory, has begun to be anthropological. As a result, both clinically and pathologically the patient has come to be considered as a person. He believes that "the work of FREUD has given new assurance of the veiled reason underlying the excessive personalism of ancient Semitic medicine, and has brought to fruition in the Freudian manner certain of the possibilities that primitive Christianity offered to medical practice." The Semitic moral sin is compared with unconscious guilt feelings, the Assyrian ritualistic examination of the inner life is contrasted with the analytic technique, and the primitive Christian physicians' doctrinal approach is equated with the Freudian requirement of acceptance of interpretation.

It was left to those who followed FREUD to extend to the "organic" ailments the auditory and anthropological attitude which he had initiated in the realm of purely neurotic disease. The final ten pages survey, all too briefly, some of the modern developments in the field of psychosomatic pathology, and a few notes of warning for the future are sounded.

Professor ENTRALGO presents his views skilfully, and if at times he is not entirely convincing, he is always stimulating. His book can be recommended to all who are concerned with the many conceptual problems facing psychosomatic medicine today.

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